

# Technology Review

MIT's Magazine of Innovation

Special  
Summer  
Issue

# Social Machines

With robot  
centerfold!  
p66

Mobile gadgets  
and the wireless  
Web create  
**Continuous  
Computing—**  
a powerful new  
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**Cool, Fun  
Summer Stuff**

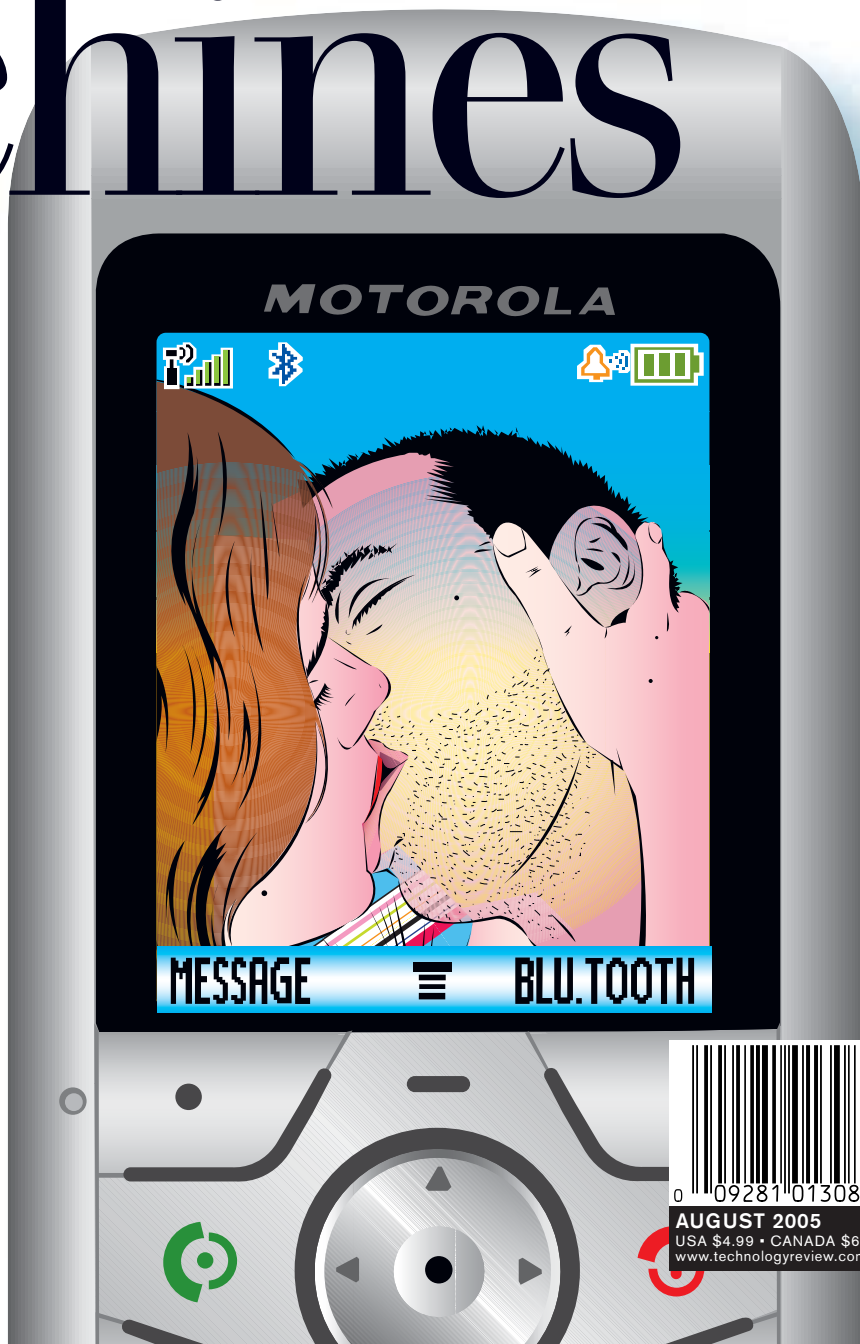
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# technology review

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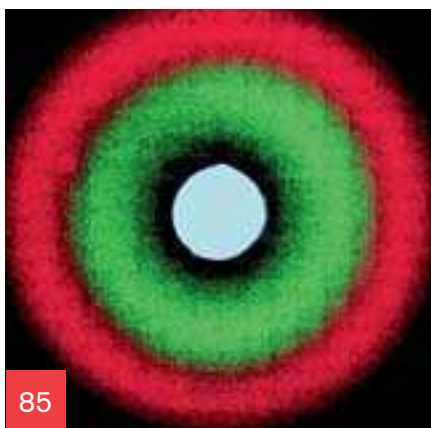


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## What's new at technologyreview.com

The Summer of Fun issue is here, and we're extending the good times beyond the pages of the magazine. After all, what good is fun technology if you can't take it with you?

Senior editor Wade Roush has invited readers into *Technology Review's* editorial process with his continuous-computing blog ([www.continuousblog.net](http://www.continuousblog.net)) and his TR blog ([wade.trblogs.com](http://wade.trblogs.com)) and has now produced a podcast ([www.technologyreview.com/podcast](http://www.technologyreview.com/podcast)). He recorded the "Podcasting FAQ Podcast" while writing this issue's review of the new tools for creating podcasts at Odeo.com (p. 70).

More fun: in this issue, Bill Joy reviews John Markoff's *What the Dormouse Said...* (p. 76), which chronicles the birth of the PC in the West Coast counterculture of the 1960s. That inspired us to solicit stories from people all over the country whose work, all those years ago, gave us today's networked world. Read them on our site ([www.technologyreview.com/dormouse](http://www.technologyreview.com/dormouse)).

**About Technology Review** *Technology Review*, the oldest technology magazine in the world, is published by Technology Review, Inc., an independent media company owned by the Massachusetts Institute of Technology. Founded in 1899, *Technology Review* describes emerging technologies and analyzes their commercial, economic, social, and political impact for an audience of senior executives, researchers, financiers, and policymakers, as well as for the MIT alumni. In addition, Technology Review, Inc. produces [technologyreview.com](http://technologyreview.com), a website that offers daily news and opinion on emerging technologies. It also produces live events such as the Emerging Technologies Conference. The views expressed in *Technology Review* are not necessarily those of MIT.



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## Contributors



**Bill Joy**, who in this issue reviews John Markoff's *What the Dormouse Said...: How the 60s Counterculture Shaped the Personal Computer Industry* (see p. 76), was the architect of Berkeley UNIX and a cofounder of Sun Microsystems. He is now a partner at venture-capital firm Kleiner, Perkins, Caufield, and Byers. "I loved Markoff's book," says Joy, "but I feel there are yet more tales to tell—beyond those about the early West Coast origins of the PC. There are plenty of stories to tell about events on the East Coast and the Midwest (where I'm from), and the connections between what was going on in the different regions. I hope Markoff writes these things up too!"



When we asked **Corby Kummer** to write about a new field whose aim is to tailor people's diets based on their genes (see "Your Genomic Diet," p. 54), he accepted, but warily. "I went into this extremely skeptical. I assumed I'd find another miracle diet, and no backup studies, and vultures eager to swoop in and cash out. But I found some very dedicated scientists who predict that, maybe not in five years, but certainly in 10, their discoveries will change the way people eat." Kummer, a senior editor at the *Atlantic* and a restaurant critic for *Boston* magazine, is one of the most respected food writers in the country. He is the author of *The Joy of Coffee* and *The Pleasures of Slow Food*.



**Craig Newmark** is the founder of craigslist, a community bulletin board featuring classifieds and discussion forums that is used by tens of millions of people. In this issue's "By Invitation" column (see p. 43), he reveals that most of what he does all day is answer e-mail from users of his site. "Hey, more and more," says Newmark, "I figure that what people need is a hand just getting stuff done and getting through the day. I never expected to be mostly doing customer service, but I've learned a lot from the phone company—and do the opposite."



The "stepfather of ecstasy," **Alexander Shulgin**, believes that psychedelic compounds can help us understand how the brain works. We asked Shulgin to look back on the drugs he invented and to explain why he believes these kinds of drugs serve a serious purpose (see "Abused Substances," p. 80). Shulgin, who was born in Berkeley, CA, 80 years ago, says he fell in love with atoms and molecules by memorizing an organic-chemistry textbook while serving in the Atlantic on a destroyer escort during World War II. "I would later spend a decade of explorative research," he says, "at the Dow Chemical Company, which led to my building my own laboratory, an early retirement, and an exciting 40 years of psychedelic research that is still going on."



**Peter Stemmler** did the artwork for this month's cover. Stemmler has, since 1999, been a freelance illustrator and designer. His work has appeared in publications such as the *New Yorker*, the *New York Times*, *Playboy*, and *Vanity Fair*; other clients include ESPN, MTV, and the SciFi Channel. Stemmler once served as a designer for a department store in Kuala Lumpur. He also once served in the East German army.

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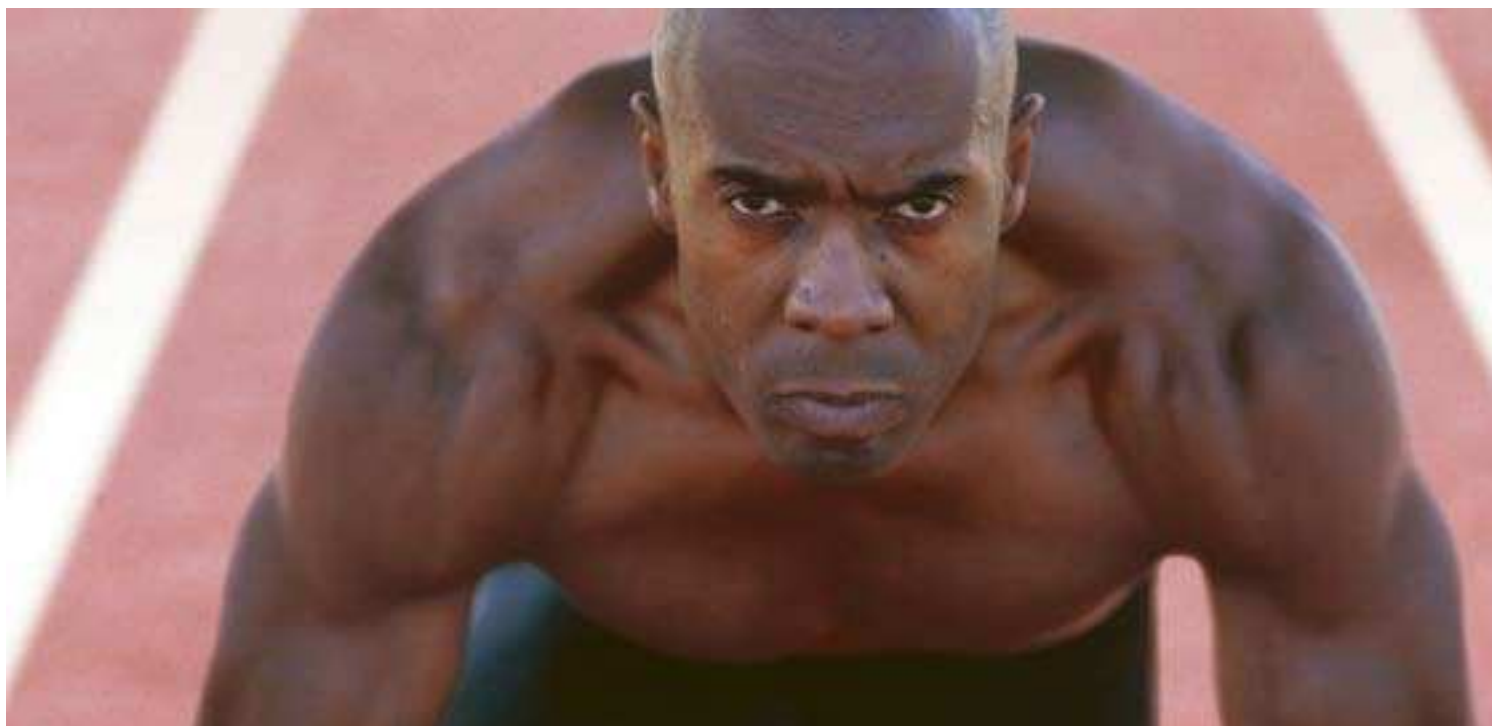
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# People and Organizations

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# Mediating Poverty

**I**N MAY, at the *Wall Street Journal's* D3 conference outside San Diego (an event attended by technology princes like Bill Gates and Steve Jobs), I saw the elements of a computer that, if it were built, would wonderfully improve the fortunes of poor children.

Nicholas Negroponte, founder and chairman of MIT's Media Lab, showed attendees the screen of the Hundred-Dollar Laptop, or HDL. Beginning in 2006, he said, he would build 100 million to 200 million HDLs every year—and distribute them to the children of the poor world. Many attendees had read about Negroponte's idea and dismissed it as quixotic. Hearing how an HDL might be built, seeing a part of it, and realizing the scale of the project produced a rustle of delighted interest.

Negroponte recently wrote to me about what he hoped the HDL would do: "Education: one laptop per child. Whatever big problem you can imagine, from world peace to the environment to hunger to poverty, the solution always includes education. We need to depend more on peer-to-peer and self-driven learning. The laptop is one important means of doing that."

Can a \$100 computer be built? Maybe. Negroponte does not plan to use three expensive components of conventional laptops: Microsoft Windows, a traditional flat-panel screen, and a hard drive. Instead, the HDL will be loaded with Linux and other open-source software; its display will use either a rear-projection screen or a type of electronic ink invented at the MIT Media Lab; and it will store one gigabyte's worth of files in flash memory.

The HDL has a number of other, intriguing features. Since many villages in the poor world do not have electricity, the machines may be powered by either a crank or "parasitic power"—that is, typing. Once turned on, HDLs will automatically connect to one another using a "mesh network" initially developed at MIT and the Media Lab. In the mesh network each laptop serves as an information-relaying node. Households that have HDLs will be able to communicate with each other by e-mail or voice calls.

Most importantly, Negroponte wants every mesh network to have access to the Internet. The laptops will be loaded with Skype, a communications application that provides free telephone calls. Consider: the most forlorn parts of the globe might become part of the wider world.

The most vital part of the plan is also, perhaps, the most challenging. Internet access is not cheap in the poor world; infra-

structure is fragile and expensive to maintain. When I challenged Negroponte about this "hidden cost," he conceded, "[This is] a very real issue. We are looking at ways to spend less than \$1 per month per child."

At first glance, Negroponte's economics seem rational enough. The HDL will not be sold commercially; instead, education ministries and other government agencies will purchase it. Profits will be very limited: merely \$10 per machine for equipment manufacturers. Of course, building a laptop for \$100 demands what economists call "economies of scale." Negroponte's pilot project requires commitments for at least six million orders. So far, China has expressed an interest in buying two million machines, and Brazil one million. At least at first, the machines would be built in China, where Negroponte has been talking to manufacturers.

Not everyone is convinced. On the record, few are willing to cast doubt on such a worthy project, but some informed people to whom I spoke wondered whether the Chinese were accurately estimating the costs of manufacturing the HDL.

But most people, like D3's attendees, are excited by the prospect of the HDL. Why? Because it represents something of a second chance. Nothing much came of attempts in the late 1990s to address inequities in the distribution of information technologies; bridging the "digital divide" is no longer a fashionable cause. But the divide is real enough for all that. According to the World

**Nothing much came of attempts made in the late 1990s to address inequities in the distribution of information technologies; bridging the "digital divide" is no longer a fashionable cause. But the divide is real enough.**

Bank, the number of Internet users per capita in the poor world is 40 percent that of the rest of the world. The rich world has three times as many computers than the poor. For more than five billion people, the Internet is only a rumor. Inevitably, poor children are the biggest losers: their lives are pathetically circumscribed. While they need clean water, food, and health care, they also need education and more-expansive horizons.

Attempts to bridge the digital divide failed because there was no bridge. Nicholas Negroponte's Hundred-Dollar Laptop could be that bridge. Do you think the HDL can be built? Write and tell me at [jason.pontin@technologyreview.com](mailto:jason.pontin@technologyreview.com). ■



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## Who Will Own Ideas?

Lawrence Lessig seems to be championing a world that would trend toward stasis (“The People Own Ideas!” June 2005). Creative thinking would be the territory of those who were independently wealthy or premeditatedly poor. People desiring to support their families would live in a world where the norm involved applying the equivalent of every filter on Photoshop and GarageBand to bits of someone else’s work. Altruism may feel good in the abstract, but living it rubs human nature the wrong way. If everybody owns ideas, no one owns ideas. And perhaps no one has ideas—or at least any they are willing to share. A generation from now, there will be an underground and then a groundswell of superb proprietary software (and music and art) created by people who value their work and are not willing to cast it into the faceless “open” sea.

**James Wish**  
Medway, MA

There is no such thing as “free.” Somewhere, someone paid the electric bill for that education. As Americans, we have built our world on our capitalist ways: you build, I buy. From Disney to Microsoft, it works. Even the giant of socialism, China, has caught on. Capitalism grows because people love more money (stuff). Giving stuff away promotes only a free-lunch crowd. Promoting the “free” may leave us on the ash heap of history.

**York T. Somerville**  
Pinellas Park, FL

Rather than give Lessig both the first and last word in the intellectual-property debate with Richard Epstein, it would have been fairer to follow his “Rebuttal!” with a final counterpoint. Editor in chief Jason Pontin’s excellent essay (“Digital Properties,” June 2005), which raised points that

both Lessig and Epstein missed and brought needed perspective to the subject, accomplished that. I hope that everyone who took the time to read the debate articles also found and read that piece.

**Benjamin Philips**  
Culver City, CA

Jason Pontin asserts that digital rights management is “a useful innovation for digital economies: someone who wanted to keep an e-book, for example, could be charged more than someone who only wanted to read it once.” What about someone like me? I won’t know until I read/view/listen to a work whether or not I want to keep it. What about this situation: I just gave away a Ken Follett book that I had read twice. On beginning the third reading, I realized that it wasn’t worth it to me and I don’t want it taking up space on my bookshelves anymore. People have always been able to give away books legally. Why not digital media? And what price should be charged to the original purchaser in a scenario like the one I just mentioned—considering that he had no idea how long he was going to retain his original copy?

**Marc Erickson**  
Edmonton, Alberta

## Open Source on the March

There’s no basis for the mischaracterization of Richard Stallman as having an “antipathy for business” (“How Linux Could Overthrow Microsoft,” June 2005). On the contrary, he has always promoted the idea that free software benefits businesses and users alike. In fact, the GNU General Public License (GPL) has specific provisions for business and sets no restrictions on the price of bundled software—other than that the source code must be made available and be freely redistributable.

**Guy Mac**  
Tucson, AZ

## Of Maps and Morals

Maps most certainly have morals (“Do Maps Have Morals?” June 2005). For evidence, just try a Google search on “gerrymander.” Modern political-demographic software has created U.S. congressional districting maps of previously unthinkable

refinement in favoring the incumbent. In fact, half the competitive seats in the U.S. House of Representatives in the 2004 election were in one state: Iowa. Why? Well, among other factors, Iowa set rules establishing that when redistricting, “no district shall be drawn for the purpose of augmenting or diluting the voting strength of a language or racial minority group.”

**Jonathan Fisher**  
Clarksville, TN

## Wanted: Technology Moonshots

As long as venture capitalists get excited only by things like social networking, we will have only lousy marginal innovations, with returns to match (“Good-Bye to Venture Capital,” June 2005). Where are the “man on the moon” kinds of projects?

**Nari Kannan**  
Pleasanton, CA

## The Technology of Killing

I love your magazine, but I have one huge complaint: too often, your articles celebrate the military. I am thinking in particular of the stories about technology used in the Iraq War (“How Technology Failed in Iraq,” November 2004), development of robotic aircraft (“The Ascent of the Robotic Attack Jet,” March 2005), and the U.S. Central Command (“Online at Centcom,” April 2005). The United States spends more than every other country combined on mechanisms of death. I want *Technology Review* to come out and state that—and to state further that it is wrong to work toward more-efficient killing. I am not some Berkeley hippie with his head in the clouds, but a guy raising a couple kids as a computer consultant. My funding of my government’s killing spree makes me nauseous.

**Jason Sjobeck**  
Portland, OR

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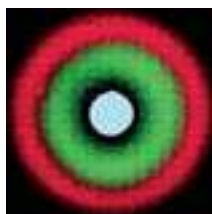
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SOCIETY

# Putting the Fun Back in Technology



Inventing the future is a difficult business, which is why the Massachusetts Institute of Technology—the owner of this publication—can be a rather serious place. MIT students are even serious about goofing off: consider the planning that goes into the clever hacks perpetrated upon the Great Dome, the campus’s architectural centerpiece. In past years students have redecorated the 46-meter-high dome as R2-D2 and topped it with a police cruiser.

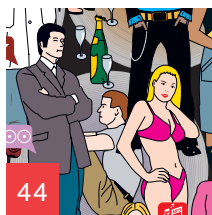
In that spirit of serious play, we present what we’ve taken to calling the “summer of fun” issue. We haven’t, of course, abandoned our focus on emerging technologies. You’ll find plenty new to chew on: a new algorithm from IBM that could make search engines more intelligent (see “*Smarter Search*,” p. 84); genetically engineered fluorescent *E. coli* bacteria that can signal environmental changes (see “*Bacterial Sensors*,” p. 85);

even an animatronic squirrel that uses social cues to manage your telephone calls (see “*Executive Squirrel*,” p. 25). But in this issue, we’ve mainly chosen to draw out the social and personal meanings of novel technologies.

Two of our features this month—on the rise of “continuous computing” and the promise of “nutritional genomics”—are previewed later in this section. Both are concerned with how technologies can change very basic, social parts of life: community and food. The third (a kind of fun travel story) is about the Kingdom of Bhutan, a poor Himalayan nation with some unusual ideas about how it should modernize and use new technologies (see “*Healthy, Wealthy, and Wise?*” p. 60).

Traditionally, *Technology Review* hasn’t written that much about society. Our subject matter is emerging technologies, and *they* have historically been purchased by corporations, universities, and governments. That’s because emerging technologies used to require an extraordinary capital investment, one well beyond the means of most people in their private capacities. Nor did most people see the need to experiment with really novel technologies. Thus the personal computer, the local-area network, the Internet itself were all first used in commercial, government, or academic settings.

But this is changing. The spread of cheap laptops, handheld devices, affordable Internet access, Wi-Fi, and a dozen other consumer technologies has led to a wonderful explosion of new social applications for them. But here’s the really interesting thing: most of these social technologies have simple editing and programming tools that let ordinary folks do innovative things that risk-averse corporations and government agencies would be hesitant to try. We suspect that *Technology Review* will be writing about the impact of new technologies on society much more frequently. Besides, social technologies are more fun. ■



COMPUTING

## Wireless Nonstop

Continuous computing now makes it easy to share your life.

An unexpected confluence in information technology could be the best news for computer users since the invention of the graphical user interface. Thanks to advances in wireless networking, Web programming, and microchips for mobile devices, consumers have access (anytime and anywhere) to a world of fundamentally *social* applications. Instant messaging and Web logs (blogs) were among the first pure social-computing technologies, but things have gone much further.

Members of Flickr.com document their lives through photography, often uploading several pictures a day from their digital or phone-based cameras. They can annotate photos with pop-up notes, play games such as “Guess Where?,” and contribute to group albums. Meanwhile, Delicious, Rojo, Furl, and several other cutely named sites let surfers share commentary on the Web pages they’ve bookmarked. Then there’s Dodgeball, a friend-finding service recently acquired by Google. People text-message their locations to Dodgeball’s servers, which relay the information to the phones of friends.

The key ingredients in this new wave of computer-mediated communication: cell phones, laptops, Wi-Fi hot spots, cellular networks, and easy-to-use websites backed by powerful databases. So many people now carry Internet-enabled mobile devices that we need never be disconnected from our friends and colleagues or from the Web. That’s why *TR* senior editor Wade Roush suggests, on page 44, giving the phenomenon a new name: “continuous computing.”

We’ve known for a while that computers can make us more efficient. Now they’re giving global reach to individual voices and killing once and for all the idea that togetherness requires physical proximity. Those screens we stare at all day? They aren’t taking us away from our real lives. They’re finally becoming part of them. ■



GENOMICS

## Double-Helix Diet?

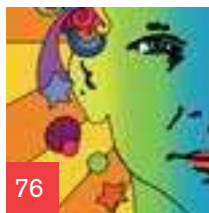
Nutritional genomics is promising, but not yet enlightening.

One of the promises of the Human Genome Project has been that it will usher in an age of personalized medicine, in which drugs will be prescribed—or avoided—based on an individual’s genetic profile. Now research groups, led by labs at the University of California, Davis, and Tufts University, are pursuing a re-

lated strategy for improving health: trying to optimize diets based on knowledge of an individual’s genome.

Should who you are (genetically speaking) determine what you eat? To learn more, we sent Corby Kummer, one of the nation’s top food writers, to sample the current research. In “Your Genomic Diet” (p. 54), Kummer gives a mixed review of the emerging field. On one hand, he found that scientists such as Raymond Rodriguez, director of the Center of Excellence for Nutritional Genomics at Davis, are doing exciting, albeit preliminary, work on the complex interactions between nutrients and the genetic variants common in different population groups.

On the other hand, Kummer suggests, the dietary advice dictated by nutritional genomics is mostly common sense: lots of soy, plenty of green vegetables, perhaps some sardines. The field is still hampered by its practitioners’ inability to cheaply and easily determine relevant genetic variants. That will change as genetic tools improve, but even so, the ability of genomic insights to change individual eating habits may be limited. Kummer, for one, concludes that he is not about to give up sweets. ■



INNOVATION

## Computing Is a Trip

Don’t forget the radical lessons from the 1960s.

This month, Bill Joy, the architect of Berkeley Unix and a co-founder of Sun Microsystems, reviews John Markoff’s book *What the Dormouse Said...: How the 60s Counterculture Shaped the Personal Computer Industry* (see “The Dream of a Lifetime,” p. 76). Joy was *there* for many of computing’s formative years, but in the course of his review, he talks as much about the future of computing as he does about its past. Not only does he enlighten readers about what it was like to help make computers more personal, but he reminds us that the computer isn’t *done*. Joy argues that what is needed to bring about the next advances in computing is for those investing in computer research to “find and fund the dreamers.”

Joy makes a persuasive argument. Doug Engelbart, whose groundbreaking work in the 1960s at the Stanford Research Institute helped pave the way for the PC, depended on large grants from the federal government. And just as important as the money Engelbart received was the freedom he enjoyed: the government knew it was funding speculative work. Today, funding both in industry and from the federal government tends to be focused on specific, short-term problems.

We can’t turn the clock back, of course. Engelbart and his colleagues had the good fortune to work at a time when America felt fresh wonder at the possibilities of technology—and had a strong faith in the productivity of brilliant scientists. But as Joy contends, we may be able to rekindle the spirit of the ’60s by imagining computers that are infinitely smarter, more responsive, and more immersive than anything we have today. By all means, let’s find and fund the dreamers. ■



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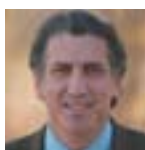
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Editor-in-Chief,  
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**Technology  
Review**



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## Voices

**"You bring two things to the table: your appetite and your genotype."**

Raymond Rodriguez, director of the Center of Excellence for Nutritional Genomics at the University of California, Davis, p. 56

**"If our bloggers are just chasing traffic by writing about Lindsay Lohan, readers won't tolerate it."**

Jason Calacanis, chairman and CEO of Weblogs Inc., p. 38

**"We're like any small company with a niche. We must modernize to survive. But we must do it in a way that ensures we are not destroying what makes us unique."**

Lyonpo Yeshey Zimba, Bhutan's prime minister, p. 62

**"Skype is going to be the phone company."**

Adam Curry, former MTV veejay and podcasting pioneer, p. 50

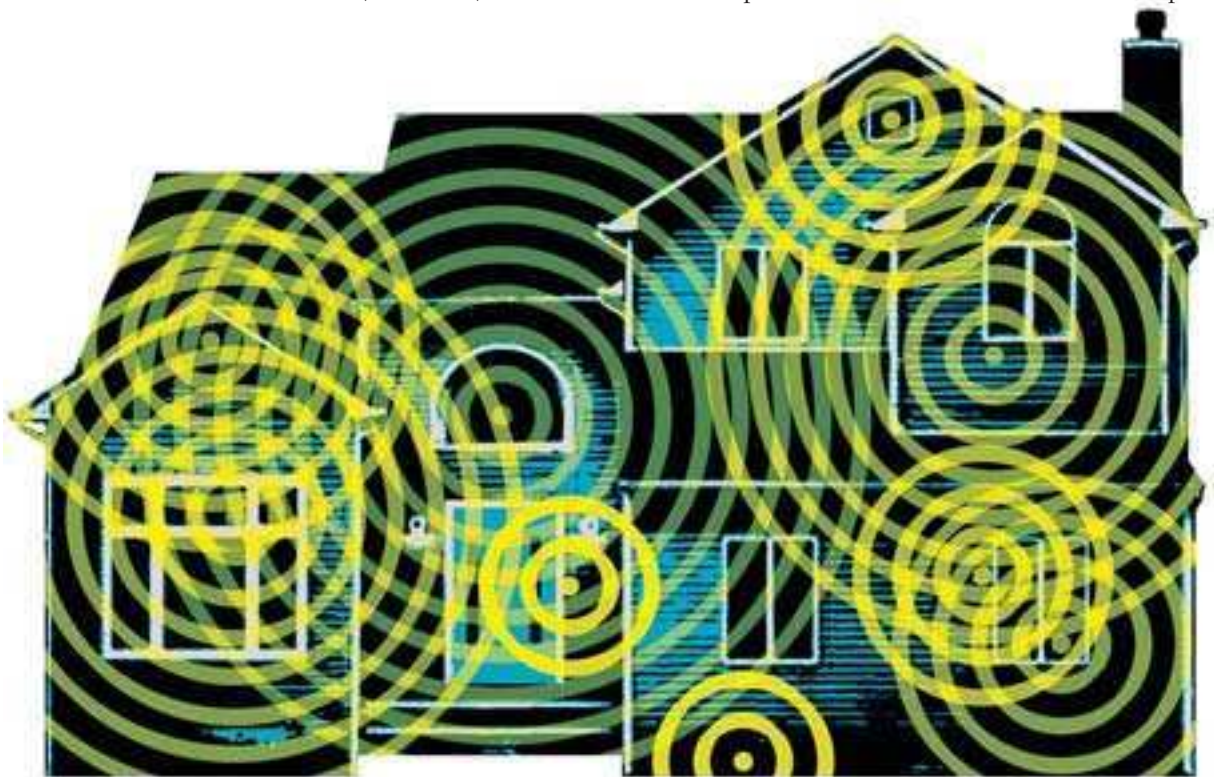
## ELECTRONICS

# Home Smart Home

A new wireless standard could finally make building-automation practical

**N**EXT MONTH, a host of new wireless gadgets designed to help make buildings and homes "smart" will debut at the ZigBee Open House and Exposition in Chicago. Among them will be a so-called domestic awareness system that warns you if the stove is left on or if the basement starts flooding. Another lets you network your home entertainment system with environmental controls such as light dimmers or a thermostat. The point of such a setup: to automatically set just the right mood when you're watching DVDs or listening to music.

Underlying these systems is a new wireless-networking standard called ZigBee. Developed by the ZigBee Alliance—which includes Honeywell, Samsung, Mitsubishi Electric, Motorola, and some 160 other companies—the standard allows household ap-



pliances, sensors, and other devices to talk to each other without the need for connecting cables.

Of course, this is by no means the first attempt to boost the IQs of buildings and homes by networking their components. So can ZigBee finally deliver home and building automation? Yes, says Chris Ryan, an analyst with U.K.-based Future Horizons who has been following the standard's development.

"The problem in the past is that adding thermostats, lighting controls, and environmental sensors to buildings has been expensive," Ryan says. ZigBee technology could cut installation costs dramatically by letting you install a light switch, say, or a heat or moisture sensor wherever you want in a building just by sticking it on a wall, floor, or ceiling. The device's embedded ZigBee chip—which costs less than five dollars—would then link up wirelessly with the appropriate light fixture or alarm, saving the exorbitant cost of install-

ing cables or wires in the wall. This kind of cost savings can make a significant difference both to the owners of large commercial buildings (which is ZigBee's initial target market) and to homeowners.

**ZigBee technology could let you install a light switch wherever you want in a building simply by sticking it on the wall—no new wires or cables required.**

But unlike Bluetooth and Wi-Fi networks, which require central hubs that distribute information to dispersed devices, ZigBee allows devices to form

mesh networks, where each unit can relay information to its neighbors. Mesh networks are far more robust than their hub-and-spoke counterparts; if a node breaks down, other nodes can automatically reroute transmissions around it. That's a big advantage in something like a building-wide lighting system: you wouldn't want one bum switch to bring the whole thing down. What's more, mesh networking could let ZigBee systems link as many as 64,000 devices; Bluetooth networks, by contrast, are limited to just eight.

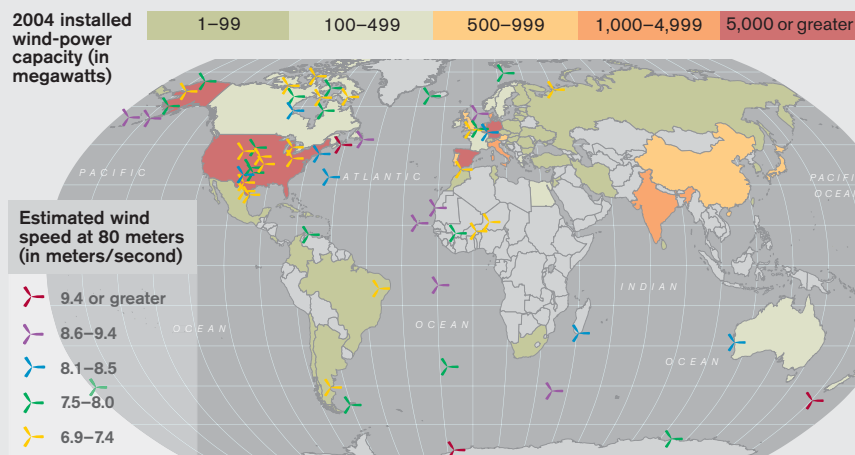
Homeowners' first taste of ZigBee is likely to come in the form of adaptors into which lamps, stereos, and other appliances can be plugged. The adaptors, which started shipping this summer, are activated by wall-mounted wireless switches or even handheld devices, which means you could soon have your whole house on one remote control.

**Duncan Graham-Rowe**

## ENERGY

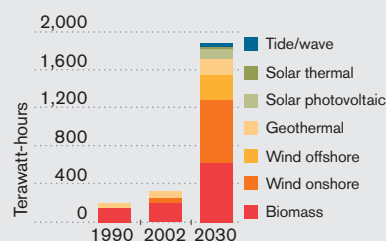
# Global Wind Power

A new study by researchers at Stanford University has estimated the global potential for wind power at 80 meters above the ground (the approximate height of today's wind turbines). The researchers used wind-speed measurements taken at 10 meters at 8,000 locations around the world to estimate wind speeds at 80 meters. They concluded that 13 percent of the sites had winds of 6.9 meters per second or faster—strong enough to make wind-based power generation cost-effective. If these locations represent a good sample of the world's land area, the researchers report, there is easily enough potential wind power to meet the world's electricity demands. In 2002, just .3 percent of the world's electricity supply came from wind power.



SOURCES: CRISTINA ARCHER AND MARK JACOBSON, STANFORD UNIVERSITY; GLOBAL WIND ENERGY COUNCIL; EUROPEAN WIND ENERGY COUNCIL; INTERNATIONAL ENERGY AGENCY

World electricity generation from nonhydroelectric renewable sources



Top 10 wind-power nations

	2004 capacity (in megawatts)	Percentage of world total
Germany	16,629	35%
Spain	8,263	18%
United States	6,740	14%
Denmark	3,117	7%
India	3,000	6%
Italy	1,125	2%
Netherlands	1,078	2%
United Kingdom	888	2%
Japan	874	2%
China	764	2%
<b>Top 10 total</b>	<b>42,478</b>	<b>90%</b>
<b>Other countries</b>	<b>4,839</b>	<b>10%</b>
<b>World total</b>	<b>47,317</b>	<b>100%</b>

Overwhelmed with phone calls and can't afford a secretary? Try a squirrel. MIT Media Laboratory grad student Stefan Marti has built a Bluetooth-enabled animatronic rodent that can manage your calls for you. Like a good assistant, the device gauges how important a caller is and how busy you are before it decides whether to bother you or take a message. Marti says that telecom companies are interested in the critter.

## Prototype continued on p. 27

# Executive Squirrel



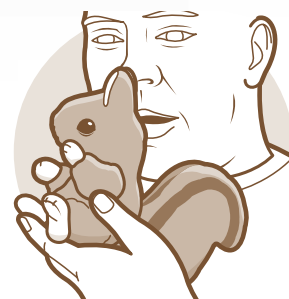
**1** In between calls, the squirrel curls into a ball, making occasional slight movements as if it were asleep. A wireless sensor network connected to the device monitors the sounds in the room to see if you're busy or slacking off.



**2** When a call comes in on your cell phone, the squirrel picks it up wirelessly and weighs its importance by asking the caller a few questions and looking up his or her phone number on a list of callers you've deemed "friendly."



**3** If the critter decides you're too busy for a call, it sends it on to voice mail. But if the call makes the cut, the device starts shimmying to get your attention; the more important the call, the more furious the squirrel's movements.



**4** If you trust the creature's judgment, just press its paw to take the call: the squirrel has a speakerphone built into it. To send the caller on to voice mail despite the squirrel's advice, press its foot instead.





Brant Sponberg  
heads NASA's  
effort to spur  
innovation with  
cash prizes.

## SPACE

# Cosmic Competition

For fresh ideas, NASA is turning to students, hobbyists, and hackers

**The \$10 million Ansari X Prize competition, which so spectacularly spurred the development of commercial space flight, ended last year; but now, NASA's Exploration Systems Mission Directorate has jumped into the game of offering prizes for technology innovation. So far, three Centennial Challenges have been announced. Brant Sponberg is the program's manager.**

### You've just announced the latest competition—lunar oxygen?

It's called Moon ROx—Moon Regolith Oxygen Challenge. Contestants have eight hours to produce five kilograms of oxygen from lunar soil. We know how to do it, but

we need to get the efficiencies to the point where it's practical.

### Where exactly are contestants getting the lunar soil?

The competition uses a simulant. It's made from volcanic ash, to simulate the chemical composition of what you'd find on the Moon. A gentleman in Texas produces it.

### Another prize is for "beam power." What's that?

You beam power from a transmitter to a receiver, which is attached to a little crawling robot. The winner is the crawler that lifts the most mass a given distance within a certain amount of time.

### What's the point of that?

Power-supply cables are heavy. On the Moon, you could beam power from, say, a small nuclear reactor or a solar collector farm to a rover or an astronaut habitat.

### And the tether challenge?

Our partner on that is the Spaceward Foundation. They're focused on a pretty futuristic concept, space elevators. You put a satellite up as a counterweight, then send a tether down to the Earth's surface. The elevators climb up and down.

### Is building something like that really on the drawing boards?

NASA has no current plans, but we are very interested in breakthrough materials. A 60,000-mile tether needs to be both strong and very lightweight. So the contest is a \$50,000 annual prize for the highest strength-to-weight ratio, provided the test sample beats the previous year's winner by at least 50 percent.

### Your biggest prizes are \$250,000 each. That's a long ways from the X Prize.

There's a legal cap on federal agencies' offering prizes larger than that. Our request for special authority to lift that is working its way through the congressional queue. There's \$10 million earmarked for challenges in our latest budget, so hopefully you'll see some bigger prizes.

### What would it take to win a big one?

A lunar robotic lander. If someone can, say, soft-land 10 kilograms on the Moon.

### Actually get it there?

Actually get it to the Moon, yes. In today's dollars, \$10 million, \$20 million, even \$30 million for a successful demonstration would be almost an order-of-magnitude improvement over similar missions that we ran back in the 1960s.

### A presidential commission talked about offering a \$1 billion prize for getting humans to the Moon.

A billion dollars is probably a bit much. But competitions let us reach innovators who would never think of applying to NASA for a grant or a contract—folks who don't like to deal with the government; hobbyists or student teams; the kid who's currently spending his time hacking websites. **Spencer Reiss**



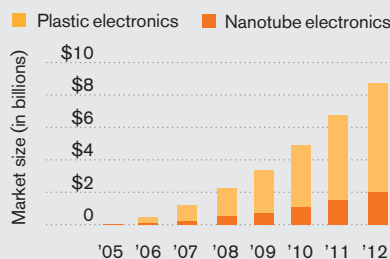
## HARDWARE

# Advanced Materials on Display

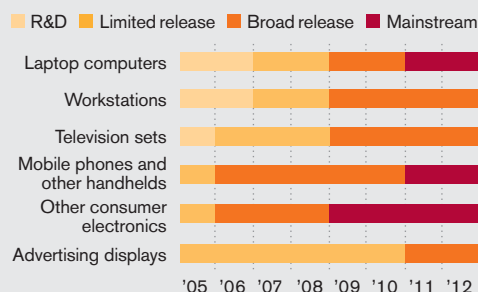
Sterling, VA-based market researcher NanoMarkets predicts that two emerging types of electronics will soon become common in displays: those made with carbon nanotubes and "plastic electronics" made with organic polymers or small molecules. The new displays promise to be exceptionally thin, lightweight, bright, and even bendable, and to consume much less power than traditional displays. NanoMarkets projects that sales of such displays will near \$9 billion in 2012.

SOURCE: NANOMARKETS

## Projected market for advanced displays



## Projected development of advanced displays, by application



## Prototype continued from p. 25



## Write Steady

For people with diseases like cerebral palsy or Parkinson's, manipulating handheld computers can be tricky. Even if they manage to hold the matchstick-thin styluses and use them to form letters and numbers, the handwriting-recognition software can still translate their shaky strokes into typos. A new text-entry method called EdgeWrite could ease those frustrations. Developed by researchers at Carnegie Mellon University, the system lets the user create each letter or number by following the edges and diagonals of a square hole in a plastic template clamped over the handheld's text input area. The edges provide stability, and unlike other input systems, such as PalmSource's Graffiti, EdgeWrite does not depend on the precise path of the stylus. Instead, its software recognizes a character by the sequence of corners hit; it can even be adapted for use with joysticks, touch pads, or trackballs. EdgeWrite co-inventor Jacob Wobbrock, a PhD candidate in Carnegie's Human-Computer Interaction Institute, is currently providing the software and home-made plastic templates for free via his website; he hopes to find a commercial partner to bring the technology to a wider market.

## Spoken-Word Search

How do you find one specific song on an MP3 player that holds thousands? You might try scrolling through menus or using a tiny

## ELECTRONICS

# Light Construction

**A** U.S. DEPARTMENT OF ENERGY study says that if homes and offices swapped their light bulbs for white light-emitting diodes (LEDs), they could slash U.S. electricity costs by \$100 billion over the next 20 years. But the LEDs themselves are expensive enough that their use for general illumination has been limited mainly to high-end buildings. So a number of major LED and lighting companies—Nichia, GE spinoff GelCore, Osram Opto Semiconductors, and Philips—are now launching an alliance to find economical ways to build LEDs into offices and homes.

The effort is now taking shape in a demonstration lab sponsored by alliance members and being built at the Rensselaer Polytechnic Institute (RPI) in Troy, NY. There, researchers intend to create a uniform set of snap-together wall, ceiling, and LED-based lighting panels that are all prewired with safe, low-voltage electrical connections. The idea is that the panels would replace both plasterboard and conventional wiring and lighting fixtures. This, says Nadarajah Narendran, director of research at RPI's Lighting Research Center, would cut construction costs enough to balance out the higher costs of LEDs; it would also make it easy and inexpensive to reconfigure living spaces. RPI is scheduled to open the demonstration lab this summer and begin holding the first focus groups with construction experts and building-materials manufacturers. **David Talbot**



Snap-together panels could light up homes and other buildings.

COURTESY OF LIGHTING RESEARCH CENTER (LIGHT); CARNEGIE MELLON UNIVERSITY (WRITE)



TELECOM

# Web Dynasty

Ben Tsiang leads China's dot-com surge

**I**N THE FRENZY of the Shanghai morning rush hour, Ben Tsiang is calm and composed. The executive vice president of product development for China's largest Web portal, Sina, is a seasoned veteran of the Internet boom and navigates startups as deftly as he does the traffic around his company's financial headquarters. "Ten years ago, people here didn't know what the Internet could do for them," says Tsiang. Now, Internet companies are helping Chinese users "leapfrog to the leading edge of technology and become even more advanced than the top of the pyramid in the U.S."

Tsiang, in his mid-30s, is the face of a new generation of developers in the world's fastest-growing Internet community. Historically, sources of news and information for Chinese citizens have been limited to state-run TV and radio. Tsiang and his peers have made their names creating homegrown Web browsers, portals, and search engines that offer more in-depth content and services than can usually be found on Chinese versions of American websites.

Like the rest of Sina's top brass, which includes executives Yan Wang, Charles Chao, and Hurst Lin, Tsiang was trained

in the West, which seems to have shaped his attitudes about information and business. From a prominent family—his grandfather was secretary general for Taiwanese leader Ching-kuo Chiang—Tsiang was born in California but grew up and went to college in Taiwan. As a graduate student at Stanford University in 1995, he cofounded Sinanet, an online news service directed at Chinese-language readers outside of China. Three years later, Sinanet merged with Beijing Stone Rich Sight Information Technology, a leading Chinese software and Internet company. The result was Sina, an all-things-Chi-

TONY LAW





Ben Tsiang thinks Web companies need to pay attention to culture, not just technology.

entertainment. In fact, the mobile market now accounts for 60 percent of Sina's revenues, through partnerships with cellular service providers such as Unicom and China Mobile. And last February, Shanda Interactive Entertainment, China's largest Internet gaming company

**Balancing market demand for Internet media, entertainment, and gaming with government policy is very delicate work, in Ben Tsiang's view.**

and a top-rated IPO in 2004, bought a 19.5 percent stake in Sina—perhaps signaling a future merger.

But hurdles abound. Says Tsiang: "The Internet is a wide battlefield." Up to this point, he says, China's Web battles have played out much like in the West, but with the action compressed into two or three years. As Sina expands, it will need to

fend off competition from more-specialized firms such as Beijing-based search startup Baidu. Another challenge: Sina and other companies must adhere to famously strict government regulations. Balancing market demand for Internet media, entertainment, and online gaming with state policy is "very delicate work," says Tsiang.

On the business side, Tsiang warns, "Never make bold assumptions according to old perceptions. Always come back to the market data." That's particularly good advice in a country of 1.3 billion people whose tastes have sometimes been perceived as uniform—or at least predictable. Sina originally believed, for instance, that the largest mobile Internet market would be in huge, affluent cities like Shanghai. But demand turned out to be stronger in Henan, a rural inland province; Tsiang says Sina's market studies hinted that the reason might be that consumers in Henan had more leisure time.

Tsiang's experience also holds broader lessons for Web companies across the globe. He says it's not enough to get the technology and business model right—you also have to understand local pockets of culture. Those companies that capitalize on this knowledge stand to do well in China and beyond. Says Tsiang, "This is where the major action will be."

**Gregory T. Huang**

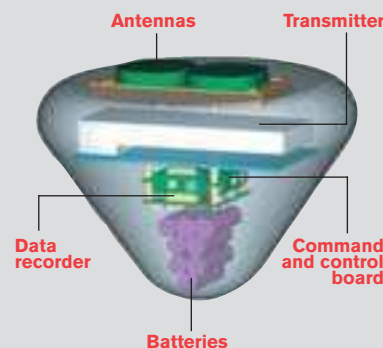
## Prototype continued from p. 27

keyboard to type in search terms—but researchers at Mitsubishi Electric Research Laboratories (MERL) in Cambridge, MA, have a better idea: use your voice instead. A Mitsubishi team led by Peter Wolf has developed a voice recognition algorithm called SpokenQuery that lets a user find music simply by saying the name of a song, band, or album—or any combination of the three. Unlike many existing voice-recognition programs, which have set menus and require users to stick to a predefined syntax, SpokenQuery allows the user to put the words in any order and even use partial names. The technology could make it possible to search for not only MP3s but also, for instance, television shows or driving directions simply by saying a few words, says Wolf. The researchers are working to pare down the algorithm's memory requirements so it can run on many different devices.

## Intergalactic Black Box

A data recorder recovered by NASA investigators after the disintegration of the space shuttle *Columbia* in February 2003 helped them reconstruct the causes of the disaster. But luck played a big part: the device had not been designed to survive breakup or impact. Now engineers at the Aerospace Corporation in El Segundo, CA, are

### Black box for spacecraft



nese portal with an emphasis on news and entertainment.

It's been a success by any measure. Since its initial public offering on the Nasdaq in 2000, Beijing-based Sina has grown into a \$200 million company with 2,000 staff worldwide and has welcomed a total of 100 million registered users on its site. In China—which already leads the world in mobile-device users and is expected to surpass the U.S. in Internet users by 2007—Sina's potential for growth is staggering.

For now, says Tsiang, Sina is fortifying its position as a news leader and is expanding into search, e-mail, and mobile

## NANOTECH

# Can Small Be Big Again?

**When serial entrepreneur Larry Bock's Palo Alto startup, Nanosys, pulled its IPO a year ago this month, it helped to deflate financial interest in nanotech. But Bock, Nanosys's chairman, says his confidence in nanotech's future has not diminished.**

**Skeptics call nanotech a great collection of small markets with no killer app.**

That's probably true in the short term, but even three years out, some of the things we'll see will be monumentally world changing.

**Is the federal National Nanotechnology Initiative (NNI) helping things along?**

One of the industry's ongoing problems is the gap between basic and applied research. People call it "the valley of death"—too big or long-range for the VCs to handle, too applied for academics. NNI should be a helpful bridge.

**Environmentalists have nanotechnology on their watch list. Are you worried about a repeat of what happened with genetic engineering?**

It has people in the industry concerned, sure. The big difference is that unlike genetic engineering, nanotechnology is a thousand different things. There's an obvious distinction between using metric tons of carbon nanotubes to fill tires versus someone making a single nanowire sensor. That's why you need to open a dialogue with critics and start doing an individual risk-benefit analysis for every application.

**More evidence that the blanket term "nanotech" is pretty useless?**

There'd be a lot less hype and confusion if everyone used the NNI definition—exploiting novel properties and functions of materials in the sub-100-nanometer size range. I don't think golf balls loaded with nanomaterials should necessarily be labeled nanotechnology.

**Spencer Reiss**

**"Nanotechnology is a thousand different things."**

Larry Bock thinks it's important to consider each new nanotechnology on its own merits.



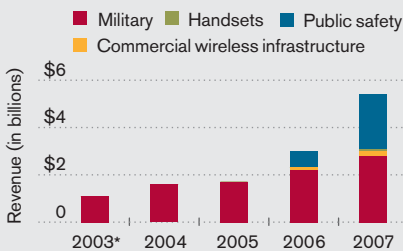


## TELECOM

## Software-Defined Radio

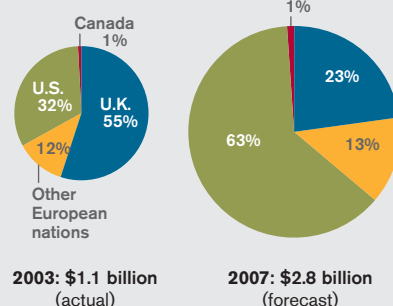
Any one of today's radio-based devices, such as cell phones, GPS receivers, and wireless modems, is likely hardwired to use a single communication protocol and frequency—one reason that many cell phones don't work when you travel abroad. Imagine instead devices that could switch easily between different protocols, frequencies, or even functions. That's the goal of software-defined radio technology, which allows the radio chip in a wireless device to change its reception and output frequency and protocol via a change in software. Military customers have been early adopters. Market researcher Venture Development predicts that further adoption by militaries, followed by the cellular and public-safety industries, will drive market revenues in North America and Europe to more than \$5 billion in 2007.

### Predicted revenues from software-defined radio in North America and Europe



\*ACTUAL FIGURE  
SOURCE: VENTURE DEVELOPMENT

### Military expenditures on software-defined radio



2003: \$1.1 billion  
(actual)

2007: \$2.8 billion  
(forecast)

## Prototype continued from p. 29

testing a device that can record factors such as temperature, acceleration, and mechanical stresses on a space vehicle as it begins to break up, then detach and carry the data safely through the plasma blaze of reentry. The recorder is about 25 centimeters across and resembles a blunt-tipped rocket cone. Its shield of insulating foam is extremely light, says William Ailor, the Aerospace engineer leading the development of the device. Once it drops into the upper atmosphere, the recorder simply falls to the earth, transmitting its data to satellites before it's destroyed on impact. Ailor says the company has successfully dropped prototypes of the device from balloons and will have a model ready to fly on expendable rockets next year.

## Gauntlet Gab

Using hand gestures to communicate instructions to troops on the battlefield may seem as antiquated as arm signaling on the highway, but it's reliable and convenient and therefore remains an integral part of troop interaction. RallyPoint in Cambridge, MA, has given the practice a high-tech update in the form of a computerized glove that reads a soldier's hand signals and relays them wirelessly to troops and commanding officers who may be out of the line of sight. The glove incorporates various sensors that measure how fingers bend and touch and detect the direction and speed of hand movements. A microprocessor translates the sensor readings into commands—"fall back," for instance—which can then be sent to other soldiers over radio equipment and conveyed as symbols on helmet-mounted view screens or as verbal commands via an earpiece. RallyPoint is waiting to hear if it will receive its next round of funding for the project from the army.

## 25 years ago in Technology Review

### From "The Case for Fuel-Cell-Powered Vehicles"

(August/September 1980, p. 60)



Fuel-cell-powered golf cart developed at Los Alamos Scientific Laboratory. Air and tanks of hydrogen currently feed the fuel cell, which is enclosed by insulation. The addition of a reformer would permit the use of methanol-water fuel mixture. (Photo: Los Alamos Scientific Laboratory)

# Online Recreation

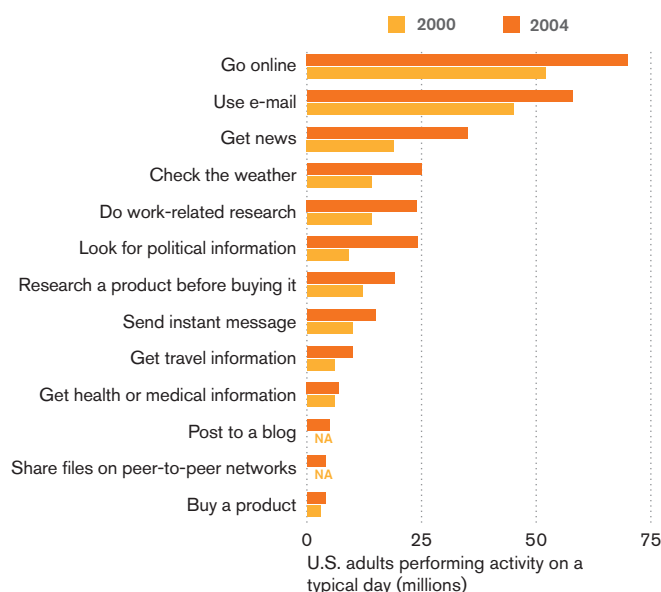
**T**HE WEB LARGELY remains a place to have fun and enjoy personal pursuits. The Pew Internet and American Life Project estimates that 70 million U.S. adults are online on a given day. Activities formerly done offline, such as checking the news and weather, are now done online by nearly twice as many people as in 2000. The market for paid content continues to expand, with sites collecting \$1.8 billion in revenue in 2004. Dating sites account for more revenue than any other type of site. Entertainment sites, such as music- and movie-downloading destinations, rank second despite 90 percent revenue growth in 2004.

But these market figures exclude two significant sources of online revenue: pornography and gambling sites. While the nature of the sites' content makes accurate estimates of their traffic and revenues difficult, Nielsen/NetRatings monitored site visits among a panel of surfers and found that during April alone, 24 percent visited porn sites and 18 percent visited gambling sites. It's no wonder, then, that there are an estimated two million pornographic sites on the Web today and that the online gambling market is expected to hit \$24 billion by 2010.

Maryann Jones Thompson

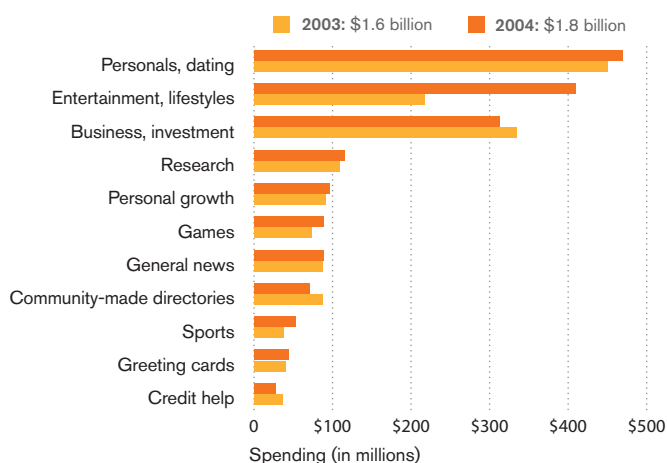
## Daily life on the Net

Significantly more Americans accessed news, weather, political, travel, and religious information online in 2004 than did in 2000.



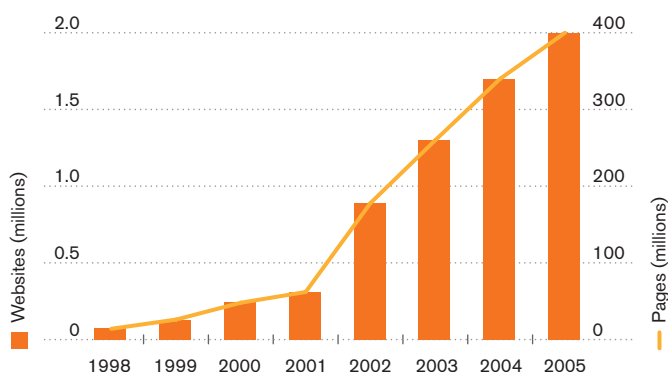
## Online-content spending

The overall market for paid content (excluding pornography and gambling) has grown from \$664 million in 2001 to \$1.8 billion in 2004.



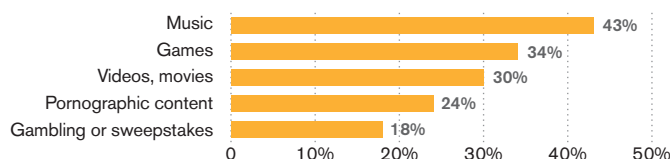
## Growth in pornographic content online

The number of pornographic websites has increased nearly 30-fold in the past seven years.



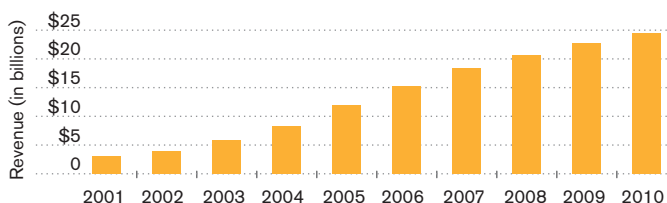
## Traffic to entertainment sites\*

Nearly a fourth of monitored Web users visited pornographic sites in April.











## Online-gambling forecast

Web-based gambling revenue will double in the next five years.



\*PERCENTAGE OF ACTIVE U.S. INTERNET USERS WHO VISITED EACH TYPE OF SITE AT LEAST ONCE DURING APRIL 2005. SOURCES: PEW INTERNET AND AMERICAN LIFE PROJECT, ONLINE PUBLISHERS ASSOCIATION/COMSCORE NETWORKS, SECURE COMPUTING, CHRISTIANSEN CAPITAL ADVISORS, NIELSEN/NETRATINGS

# Funding of Innovative Startups

Company	Founded	CEO	Recent funding	Key investors	Technology	Prospects
<b>Caspian Networks</b> 	1999 San Jose, CA	Brad Wurtz	\$55 million	Oak Investment Partners, U.S. Venture Partners, Morgenthaler Ventures, New Enterprise Associates, Alloy Ventures, and ABN-AMRO	Routers that help service providers control, manipulate, and monitor Internet protocol-based traffic	<b>This startup's core technology is promising and timely. Initial infrastructure products have already been introduced in the commercial marketplace for service providers.</b>
<b>Phenomix</b> 	2001 San Diego, CA	Laura Shawver	\$40 million	JPMorgan Partners, Delphi Ventures, Baker Brothers Investments, Alta Partners, Sofinnova Ventures, Bay City Capital, CMEA Ventures, GBS Venture Partners, and Novartis BioVenture Fund	Drugs for immune disease and metabolic syndromes	<b>Treatments for type 2 diabetes and rheumatoid arthritis are scheduled to begin clinical trials this year.</b>
<b>Avidia</b> 	2003 Mountain View, CA	Peter Van Vlasselaer	\$28.5 million	Morgenthaler Ventures, TPG Ventures, Amgen Ventures, MedImmune Ventures, Alloy Ventures, Maxygen, and Willem Stemmer and other individuals	Biotherapeutic proteins that bind to multiple targets at once and that could be used to treat a range of disorders, including autoimmune disease, inflammation, and cancer	<b>Avidia says its approach is faster and cheaper than current methods of producing protein drugs. Boehringer Ingelheim Austria recently signed on as the manufacturing partner.</b>
<b>Quorum Systems</b> 	2002 San Diego, CA	Bernard Xavier	\$15 million	Greylock Partners; Kleiner, Perkins, Caufield, and Byers; and Enterprise Partners Venture Capital	Chip that supports both cellular and Wi-Fi connections	<b>With products ready for the market, Quorum is hoping it is at the leading edge of a convergence of wireless technologies.</b>
<b>Codon Devices</b> 	2004 Cambridge, MA	Samir Kaul	\$13 million	Flagship Ventures, Alloy Ventures, Kleiner Perkins, and Vinod Khosla	Rapid, low-cost synthesis of DNA to produce genetic parts needed for the emerging field of synthetic biology	<b>If successful, the startup's technology could enable the development of new biosensors, engineered cells that produce novel drugs, and better vaccines.</b>
 Will take time to reach market  Strong competitive position  High-benefit, high-risk technology						

## Company Spotlight

**Caspian Networks** When it comes to corporate pedigree, you can't get much better than Caspian Networks. The company was started in 1999 by Lawrence Roberts, one of the founding fathers of the Internet. In the mid-1960s, Roberts was chief scientist for the U.S. Department of Defense's Advanced Research Projects Agency, whose computer packet network ARPAnet evolved into the modern Internet. Roberts later founded Telenet, the first packet data communications carrier.

Now Roberts is hoping to transform today's Internet. In its latest announcement, Caspian says it has gained another \$55 million in funding from its existing investors. Caspian is touting routing technology that lets communications service providers efficiently manage Internet protocol (IP) traffic across their networks. This type of control and optimization is

increasingly important to service providers as IP-based traffic, which now includes video, gaming, music downloads, HDTV, and voice over IP (VoIP), gets heavier.

Caspian recently announced an agreement with ETRI, a research center supported by the South Korean government, to develop a network reaching 20 million broadband users in that country, and the company also signed a codevelopment pact with Northrop Grumman, the aerospace and defense systems company, to work on a project for the U.S. Air Force.

**Quorum Systems** Wi-Fi is quickly becoming pervasive, and yet there is a gap between wireless data networks like the one you connect to at Starbucks and the wireless cellular networks that connect our mobile phones. Enter San Diego-based semiconductor company Quorum Systems, which is marketing a chip that

will unify these networks, allowing both the Wi-Fi and cellular functions to operate in the same handset.

While a number of other chip makers are working to make dual-mode chips, Quorum claims an advantage in its low-cost design; the company argues that dual-use handsets will not take off unless they are attractively priced. As for the pitch to network operators, it's simple: your customers will be happier because they're getting better, more reliable coverage and the advantages of both Wi-Fi—including VoIP—and cellular service.

Some market researchers believe sales of dual-mode phones could reach 100 million units by the end of this decade. The challenges for Quorum will be to help the market mature and to make certain that its chip resides in some significant portion of those phones.

**Andrew P. Madden**

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# Up, up, and...which way? East.

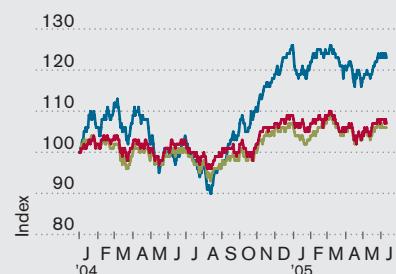
Technology stocks look expensive—except in Asian countries other than Japan

**I**T WAS A STRONG four weeks for the majority of companies in the *Technology Review* indices, with only four of twenty industry groups showing negative returns. In terms of market capitalization, the stocks of small-cap companies continued to outpace those of their larger peers, and the *TR* Small-Cap 50 is up a remarkable 24.7 percent for the year ending June 10. But we live in nervous times, and such a performance is therefore as much a cause of concern as it is of celebration. So, at least, says one of the smartest observers of all things tech-stock related.

Pip Coburn, the global tech strategist for investment bank UBS, points out that on a price-earnings basis, technology stocks are trading at a lofty premium of 33 percent relative to the broader market, despite projected earnings growth in 2005 of just 9 percent for both groups. His prognosis: a narrowing of that valuation gap over the next 12 to 18 months, as technology stock prices fall “in a slow but steady bleed.” That’s the bad news. The good news is that he still sees some stocks worth paying a premium for, including *TR* Large-Cap 100 member Apple. He also points out that non-Japanese Asian technology stocks are the only ones trading at a discount relative to nontech—an 18 percent haircut—while European and Japanese tech stocks trade at nearly absurd premiums of 55 percent and 39 percent, respectively. If it’s bargains you’re looking for, go east, young tech investor, go east. **Duff McDonald**

**The *TR* Large-Cap 100 and Small-Cap 50 indices live online, where they are updated daily. Visit [www.technologyreview.com/trindex](http://www.technologyreview.com/trindex).**

## TR stock index comparison



	% change 5/13–6/10	One-year % change
— <i>TR</i> Large-Cap 100	2.5%	5.1%
— <i>TR</i> Small-Cap 50	4.3%	24.7%
— S&P 500	3.2%	4.8%

## TR Large-Cap 100

	% change 5/13–6/10	Total market cap (millions)
Energy	7.1%	\$1,257,303
Semiconductors and equipment	5.1%	\$407,126
Aerospace and defense	4.4%	\$241,435
Consumer	3.3%	\$184,253
Computers	3.3%	\$725,106
Software and services	1.9%	\$483,120
Health care	0.5%	\$207,593
Telecommunication services	0.2%	\$747,690
Media	-0.8%	\$454,695
Biotechnology and pharmaceuticals	-0.8%	\$1,195,464

## TR Small-Cap 50

	% change 5/13–6/10	Total market cap (millions)
Media	15.5%	\$13,449
Computers	10.9%	\$17,590
Consumer	6.3%	\$2,759
Software and services	6.0%	\$16,769
Health care	4.8%	\$10,092
Aerospace and defense	2.8%	\$6,061
Semiconductors and equipment	2.1%	\$8,272
Biotechnology and pharmaceuticals	1.2%	\$11,897
Energy	-0.8%	\$9,362
Telecommunication services	-2.6%	\$3,319

## TR Large-Cap 100, top gainers

	% change 5/13–6/10	One-year % change
Best Buy (NYSE: BBY)	17.7%	10.2%
Nextel Communications (Nasdaq: NXTL)	14.5%	30.8%
Hewlett-Packard (NYSE: HPQ)	14.0%	8.0%

## TR Large-Cap 100, top losers

	% change 5/13–6/10	One-year % change
Merck (NYSE: MRK)	-6.2%	-34.3%
Nintendo (Tokyo: 7974)	-5.8%	-8.6%
Boston Scientific (NYSE: BSX)	-5.6%	-31.4%

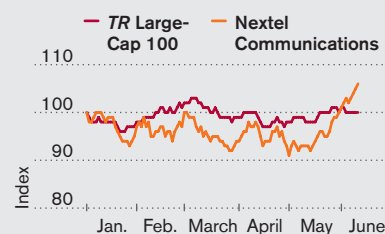
## TR Small-Cap 50, top gainers

	% change 5/13–6/10	One-year % change
CMC Magnetics (Taiwan: 2323)	21.9%	-18.8%
Grant Prideco (NYSE: GRP)	17.3%	59.9%
Western Digital (NYSE: WDC)	14.6%	71.8%

## TR Small-Cap 50, top losers

	% change 5/13–6/10	One-year % change
First Calgary Petroleum (Toronto: FCP)	-34.3%	-20.5%
Valeant Pharmaceuticals (NYSE: VRX)	-10.7%	5.9%
Havas (Nasdaq: HAVS)	-7.5%	8.4%

## In depth: Nextel Communications



Nextel Communications is the fifth-place also-ran in a five-company sprint to the wireless finish line. Because of its laggard status, Nextel has agreed to be acquired by Sprint later this year, and integration plans are ongoing. Suddenly, it seems, investors are finding Nextel stock interesting again. But don't expect a bidding war along the lines of the Verizon-Qwest battle for MCI. Nextel looks to be spoken for.

NOTE: IN THE *TR* SMALL-CAP 50, PLAINS EXPLORATION AND PRODUCTION HAS REPLACED PATINA OIL AND GAS IN THE ENERGY INDUSTRY. SOURCES: STANDARD AND POOR'S CUSTOM INDEX SERVICES, *TECHNOLOGY REVIEW*, YAHOO FINANCE

# The Business of Blogging

**THE CASE:** Blogs are the soapboxes of the Internet era—independent platforms for everything from personal diatribes to political discourse to tech-gadget reviews. But with their growing popularity, could blogs also become media platforms capable of making money? Two entrepreneurs are trying to find out.

**D**EPENDING ON whom you talk to, Web logs, or blogs, inspire excitement, alarm, or a yawn. They are the personal diaries that now litter the Web, composing a newish on-line medium that is simplicity itself.

Most blogs consist of musings posted to idiosyncratic and amateurish websites. But while blogging is a favored mode of expression for blowhards of every stripe, it is also the basis for a new crop of editorial products with high-quality content and loyal readerships. Over the past several years, blogs have become platforms for political discourse, Hollywood gossip, and insider information on subjects ranging from the latest Apple operating system to presidential-election results.

Several factors have contributed to the emergence of blogs. First, they can be started with very little, and very inexpensive, editorial content yet are capable of exerting extraordinary influence. Blogging software is inexpensive—or often free—and easy to use. Low bandwidth requirements and Web-hosting fees keep the ongoing infrastructure costs of maintaining a blog very low. And new, easy-to-use advertising services such as Google AdSense, which frees content creators from having to deal with actual advertisers, have breathed fresh life into online media.

The accessibility and ease of use of blogs have had a dual effect, a simultaneous erosion and improvement of quality. At the low end, blog-platform sites like LiveJournal and Xanga provide an outlet for hobbyists and diarists. More-serious bloggers, however, have increasingly approached their sites as they would any



Brian Alvey



Jason McCabe Calacanis

## Weblogs Inc.

**Headquarters:** New York, NY

**Bloggers under Weblogs' umbrella:** 80

**Total monthly page views generated by**

**Weblogs bloggers:** 60 million

other sort of editorial platform, with regular publishing schedules and clear editorial missions. These bloggers tend to use more-sophisticated software than do more-casual bloggers. One such tool is Movable Type, made by San Francisco-based Six Apart. Movable Type is customizable and can help make a blogger's postings look professional.

All these trends are leading a number of media entrepreneurs to wonder whether blogs can generate meaningful revenues or, for that matter, offer a legitimate alternative to the business models of existing media companies.

Two of those entrepreneurs are Brian Alvey and Jason McCabe Calacanis. They are the cofounders—Alvey is president and Calacanis is chairman and CEO—of Weblogs Inc., a network of 80 blogs. The pair bootstrapped Weblogs with their own funds, and barely 18 months after the network's January 1, 2004, launch,

they were already earning revenues. But it remains to be seen whether the business model will deliver profits.

## New Medium, Old Partners

This is not the first time Calacanis and Alvey have collaborated. They attended the same Brooklyn high school and started their first venture, a magazine about on-line services called *Cyber Surfer*, in 1994. Two years later they launched *Silicon Alley Reporter*, a magazine that covered Internet startups and served as an East Coast foil to the better-known California-based tech tomes of the late 1990s, such as *Red Herring* and the *Industry Standard*.

*Silicon Alley Reporter* prospered in the days of profligate advertising budgets, and it launched additional businesses, such as an events-planning division, e-mail newsletters, a website, and a radio show. Calacanis established himself as a familiar pundit of the East Coast tech boom. He served as CEO of the company, while Alvey, who built *TV Guide's* website in 1995 and was a member of the team that built the first *BusinessWeek* site later that year, was chief technology officer.

When the market crashed in 2000, and other Internet-focused media companies went out of business, Calacanis retooled *Silicon Alley Reporter* to focus on venture capital. In 2001, he changed the name to *Venture Reporter*, ditched the advertising-based business model, and increased the price of the magazine, turning it into a high-end business-information offering. *Venture Reporter* charged up to \$1,000 for research reports and from \$1,000 to \$5,000 for access to a proprietary database of information about venture capital investment and mergers-and-acquisitions activity. The makeover narrowly rescued the company from oblivion. After *Venture Reporter* was acquired, first by Wicks Business Media and then by Dow Jones, Alvey, and eventually Calacanis (who stuck around until 2004), decided to move on.

In early 2003, Calacanis and Alvey began to discuss new business ideas in the media sector. They'd followed the blogging exploits of two former *Silicon Alley Reporter* employees: Xeni Jardin, who is a contributor to the popular collaborative blog Boing Boing, and Rafat Ali, who publishes PaidContent.org, a blog about

emerging new-media business models. Calacanis saw the validity of one of those models as he observed the immediacy of Jardin's and Ali's postings, the value of their information, and the loyalty of their readerships. "It wasn't hard to see that there was this new model emerging where writers are unfiltered and readers actually like it as much as, or perhaps even more than, they like magazines," he says. "And they certainly appreciate that the content is available on a more regular basis."

### The Network Effect

But as Calacanis and Alvey began to study the economics of blogging, they encountered a question that few bloggers have been able to answer: how to expand. "We looked at individual blogs and couldn't figure out when or how you add employee number two. Maybe never?" explains Alvey. "We wanted to put together a blogging franchise that could actually grow."

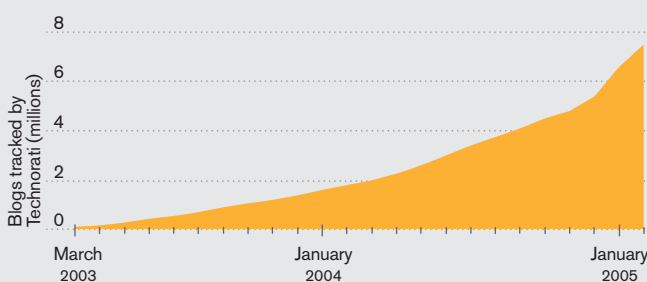
It was clear that growth couldn't happen at the level of the blog. A stand-alone blog tends to have a single author, a narrow focus, and a small audience. It is thus unlikely to benefit from Google AdSense, an automated contextual-advertising program that becomes lucrative for site owners only when traffic increases to hundreds of thousands of page views per month. In a best-case scenario, a blogger with low traffic might be able to make money by finding a sponsor willing to pay a premium to reach a targeted audience.

Calacanis and Alvey's solution was to assemble a large network of bloggers who together would generate a river of traffic. Stand-alone bloggers face great pressure to keep their sites fresh for audiences who expect frequent updates. With a network, if fresh content is not available at one blog, it most likely will be at a sister blog with overlapping coverage—and authors can contribute to one another's sites.

The final business plan for Weblogs called for a network of more than 500 blogs targeting niche markets in technology, media, entertainment, and consumer goods. With his experience in creating content management systems,

### Blog Growth

Technorati, a popular blog search engine, estimates that 30,000 to 40,000 blogs are created and 500,000 posts made each day.



SOURCE: TECHNORATI

Alvey built the publishing platform from the ground up; he believed that commercially available blogging programs such as Movable Type couldn't handle such a large number of blogs and didn't offer the kinds of reporting tools that Weblogs wanted to build into its system.

In early 2004, Calacanis and Alvey began to recruit writers into the network. "When we started, there weren't that many blogs out there that had reached any

**"We looked at individual blogs and couldn't figure out when or how you add employee number two," recalls Weblogs Inc. cofounder Brian Alvey. "Maybe never?"**

level of significance," says Calacanis. "For any of the ones that had, we went and talked to them and tried to see if there was a deal we could do. We made offers to buy or partner with them."

But bloggers are independent spirits. Few established bloggers wanted to partner with the company or sell controlling interest in their content, Calacanis found. Nor did the bloggers, many of whom had been stung by the dot-com crash, have much interest in Weblogs equity.

Engadget, a Weblogs site that covers technology devices, was an exception. It is now the most popular blog in the network and ranks among the most popular on the Web. Its author, Peter Rojas, had previously written a similar blog called Gizmodo for a rival network, Gawker Media. [Disclosure: Rojas worked for Jason Pontin, *Technology Review's* editor in chief, when Pontin was editor of *Red Herring*.] According to Gawker founder Nick Denton, Rojas sought an equity stake in the business,

but Denton was unwilling to offer one. Calacanis poached Rojas from Gawker, by offering him a new platform and an undisclosed equity stake in Weblogs. But Rojas's contract is an exception for the company, says Calacanis: "Nineteen out of 20 people we talked to rejected the idea of equity. Most just want that paycheck."

As a result, almost all Weblogs bloggers are freelance contractors who are paid on a monthly basis. They make anywhere from \$100 to \$3,000 a month, with the average falling between \$500 and \$600, says Calacanis. Contract negotiations are based on a number of factors, including how often the blogger updates his or her site. The Weblogs network currently includes 80 bloggers and generates 60 million page views per month. Weblogs is the exclusive copyright holder on all the content it publishes.

The company is generating a steady stream of revenue from network ads, which are automatically served by companies such as Google and Tribal Fusion, and from direct ads, which are the result of traditional contracts with such advertisers as Volvo, Equifax, Pacific Poker, Palm, and Subaru. According to Calacanis, the majority of the company's revenues come from direct ads, which currently command a CPM rate (cost per 1,000 impressions) of between \$4 and \$12, whereas network ads generate between \$1 and \$4 CPM. The most popular blogs tend to feature a greater number of ads purchased directly by advertisers. More than half of Weblogs' advertisers end up buying space on more than one of the network's blogs, says Calacanis, but to pique a direct adver-



# Briefcase

tiser's interest, a blog's traffic must exceed one million page views per month.

The company openly experiments with homegrown ad formats, including Focus Ads, which invites users to comment on ads, and "adverposts," which are ads written in a blog format (though they are clearly labeled as ads). Weblogs Inc. has also begun to embed ads in its RSS feeds. RSS ("really simple syndication") allows content providers to disseminate the information on their sites, including links, headlines, and summaries of stories, to an RSS reader—a software program that aggregates the updated content from a person's favorite sites, eliminating the need to visit them individually. An advertisement within an RSS feed appears as a text link, much like a Google "sponsored link" on a Web page. With this new advertising format, the ads accompany the content wherever it goes.

One potential pitfall of the reliance on automated ad programs is the temptation to game the system by creating search-friendly editorial content referring to highly trafficked search subjects, like Paris Hilton. Calacanis maintains, however, that the practice of gaming search engines is quickly punished by readers. "People come to blogs not to be duped—to get genuine coverage," he says. And while he admits that blog publishers have fostered a spirit of collaboration with advertisers, he says the so-called Chinese wall between editorial and advertising is essential to establishing the credibility of commercial blogs, just as it is for traditional forms of media. For this reason, Weblogs rejects the idea of tying compensation for a specific blog to its ad performance; the company wants its content to be as genuine as possible. "If our bloggers are just chasing traffic by writing about Lindsay Lohan, readers won't tolerate it," Calacanis says.

Though Calacanis and Alvey will not disclose revenues, Calacanis—in the collaborative spirit of blogging—has shared certain details on his own blog (calacanis.weblogsinc.com). Weblogs generates more than \$1,000 per day from Google

AdSense alone and has recently surged as high as \$2,000. Maintaining that average would translate to \$730,000 in revenue in a year, "which is nice," Calacanis observed on his blog, "but much, much, less than we write in checks to our team every month (think 75+ bloggers and 10 full-time staff)." In May 2004, Mark Cuban,

## A potential pitfall of the reliance on automated ad programs is the temptation bloggers may feel to game the system by creating search-friendly editorial content.

who sold Broadcast.com to Yahoo at the height of the bubble for an astonishing \$5.7 billion, made an investment in the company. His own personal blog, Blog Maverick, is part of the Weblogs network. Calacanis says he has no immediate plans to raise more money.

### No Barriers to Entry

Calacanis openly refers to his latest venture as a "blog experiment," and to be sure, it is an unproven model. In addition to competing with other networks, like Gawker Media, which currently publishes 13 blogs, Weblogs must compete with

businesses using other emerging models. John Battelle, who founded *Industry Standard* and writes SearchBlog, a blog about the intersection of media, technology, and the Internet, has launched a venture tentatively called FM Publishing that will provide independent blogs with such services as ad sales, but will not own their content.

With this approach, Battelle may be able to attract high-end bloggers who want to maintain ownership of their editorial content but don't have the time and resources to figure out how to

monetize their blogs. And by bringing prominent blogs together, FM Publishing could begin to enjoy some of the same network benefits that Weblogs does.

A similar venture, called BlackInc Media, is being launched later this year by former CNET Networks employees. The company will help blog publishers with ad sales and business development. "Our goal is to allow bloggers to focus on the thing that made them valuable in the first place—good editorial content," says Matt Comyns, one of BlackInc Media's founders.

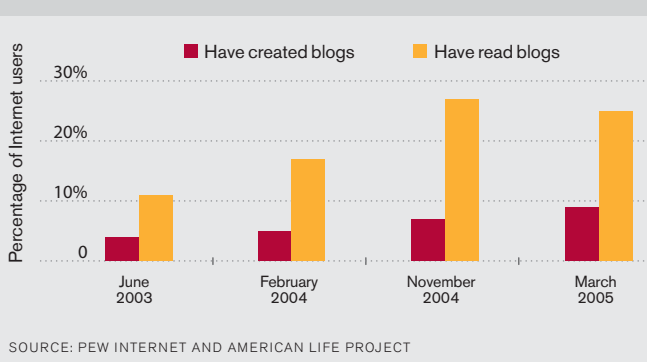
Another, less tangible challenge facing Weblogs is the fickle nature of Internet trends. The influence that bloggers wielded in the national debate during last year's presidential election suggests that the medium's cultural importance is unlikely to fade anytime soon. But that doesn't guarantee that advertisers will ultimately find sufficient value in blogs. To date, most advertising has been conducted on an experimental basis.

Calacanis believes that blogs need not revolutionize media in order to be successful. "The problem is that lots of people want to make this a zero-sum game," he says. "I don't see blogs cannibalizing what Google News does or what the New York Times does. I see it as something unique. I think blogs will eventually represent 20 percent of a person's media diet."

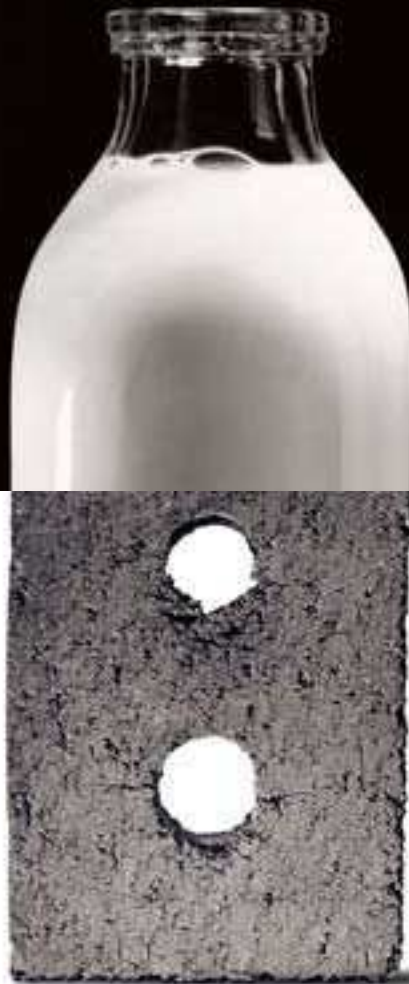
If he's right, then blog networks—and even some stand-alone blogs—may be able to carve out a comfortable existence. But in the end, a blogging company's greatest weakness may be the very thing that makes the new medium so powerful: anybody can publish a blog. **Andrew P. Madden**

### Creation and Reading of Blogs

Nine percent of Internet users have created blogs, and 25 percent have read blogs, representing, respectively, 6 percent and 16 percent of U.S. adults overall.



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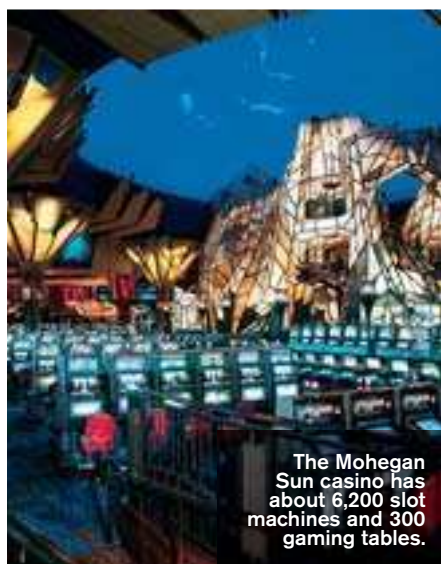
# The Digital Pit Boss

**THE CASE:** Connecticut's Mohegan Sun casino is preparing to go "all in" on a sensor-riddled blackjack table that will give the house perfect knowledge of how its customers play. It found that a relatively low-tech system of cameras is more sensible than RFID—and that customers will tolerate electronic surveillance if they believe it offers them benefits.

**F**OR A CASINO, the expenses and profits at blackjack tables are difficult to precisely pin down. What's clear is that the aggregate numbers are staggeringly high: a typical blackjack table in Reno, NV, can see more than \$6 million wagered monthly, with about 1 percent of that sum staying behind as the casino's winnings. But gauging the performances of individual players has long been an inexact science. Clay gaming chips slide back and forth between human hands. Paper playing cards are dealt, collected, and shuffled. Players signal their desire for additional cards by tapping their fingers on the table and refuse hits by waving their hands. Some expend all their chips; others walk away with more than they brought.

Casinos hunger for a better understanding of players. In particular, they want information that will help them refine how often, and to whom, they dole out "comps"—a sort of casino currency redeemable for treats like free hotel rooms, dinners, and drinks. This calculation requires two primary pieces of information: how much a given player is wagering, and—for blackjack and some other card games—how skilled that player is.

Knowing how much players are wagering requires watching their chips closely, and judging their skill levels accurately requires observing each decision they make. Right now, the onus for keeping track of these things falls to a manager known as a pit boss, who is, famously, backed up by surveillance staff eyeballing video monitors in a back room. Like other casinos, Mohegan Sun, in Uncasville, CT, thinks



The Mohegan Sun casino has about 6,200 slot machines and 300 gaming tables.

## Mohegan Sun

**FY 2004 revenues:** \$1.13 billion

**Employees:** 9,700

**Average daily visitors:** 30,000

technology can help it track blackjack players. "We have long been looking for a technology that would help us provide automated ratings of players at gaming tables," says Dan Garrow, the chief information officer at Mohegan Sun. "If you spend \$10,000, we will do something for you to keep coming back. It's no different than any other business—how do you keep your customers coming back?"

But of course, gambling is different from any other business. While a casino does, as Garrow says, care about customer retention as much as any company, its relationship with its customers is adversarial: a casino wants its customers to lose. "Each

player represents what we call a 'theoretical win,'" says Garrow. "You would call that a loss." That is what makes comping so important: it is the method by which casinos try to soften the edges of the hard reality of loss. And how comping is done matters greatly: the trick is to lavish the biggest gifts on the people who are most likely to not only place big bets but also make decisions that worsen their odds.

Casinos know that technology can help them identify those people. Garrow explored—but has rejected for now—prototype systems that use radio frequency identification (RFID) tags embedded in gaming chips. This technology gives each chip a unique identifying code; as a player buys chips (after first showing a player ID card to become eligible for comps), the chips are electronically associated with that player. At blackjack or other tables, a tag "reader" identifies each movement of each chip, registering how much has been bet, won, and lost. As a side benefit, such chips are nearly impossible for employees to steal or players to counterfeit.

While a few casinos are testing prototype RFID-chip systems, none has yet implemented them, says John Kendall, president of one RFID-gaming chip maker, Chipco International of Raymond, ME. When Garrow investigated RFID chips, he concluded they were too costly, though he acknowledges that prices have since come down. (The newest versions add about 50 cents to the 80-cent price of a traditional casino chip, Kendall says.) Moreover, while RFID technology provides detailed information about players' betting patterns, it reveals nothing about the cards they base their bets on, and therefore nothing about their skill at blackjack.

While searching for alternatives, Garrow courted lone inventors proposing technology for blackjack tables. At one point he and his staff found themselves in the 13th-floor Manhattan apartment of an inventor who had rigged a blackjack table with computers and sensors to track all aspects of play. While the technology showed promise, the vendor was essentially looking for Mohegan Sun to provide his venture capital and expand his business—something Garrow was unwilling to do.

Then came MindPlay. Garrow was aware that a couple of casinos in Nevada had been trying out a system from Mind-



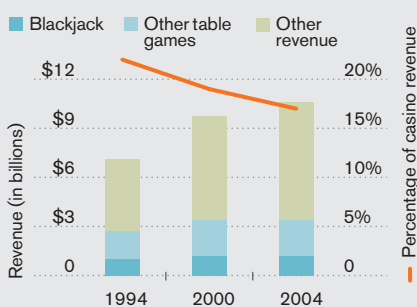
Play, a small, Bellevue, WA-based company that has since been bought by Bally Gaming and Systems. MindPlay builds blackjack tables with small cameras tucked into a slightly raised dealer platform facing the players. The accompanying gaming chips bear simple line patterns on their edges; these are read by the system's pattern-recognition software. Special playing cards also bear line patterns that identify them; the patterns are on the faces of the cards and are read by a camera pointing up through the table at the mouth of the "shoe"—the box containing cards.

Players swipe their casino cards at the start of play—so they can earn comps—and thereafter, every detail of their play is tracked. The system knows which cards they receive, what decisions they make, and the amount of each bet they make. A back-end system continually evaluates and reevaluates their skill, hand by hand, hit by hit. (The theoretical best player, who plays strategically perfect blackjack, will have a mathematical disadvantage of .45 percent; each mistake he or she makes drives that number upward.) The software's skill assessments are fed into the casino's management software. In a final, tangible touch, the playing surface of the MindPlay blackjack table has the feel of a mouse pad.

Paving the way for Mohegan Sun was the El Dorado casino in Lake Tahoe, NV, which did its beta testing four years ago. Now the casino has implemented 16 MindPlay tables. And what kind of data is it getting? Rob Mouchou, El Dorado's vice

### Casino-Revenue Snapshot

Blackjack brought in \$1.2 billion to Nevada casinos in 2004, but the game's portion of overall revenue has declined since 1994.



SOURCE: AMERICAN GAMING ASSOCIATION, NEVADA GAMING CONTROL BOARD

president of operations, made a few mouse clicks during a phone interview and reported that in a recent 30-day period, 5,795 skilled players who swiped in using player ID cards wagered \$16.6 million at the 16 MindPlay tables.

A few mouse clicks later, he saw the payoff to the casino on these players. Before MindPlay, Mouchou comped players at a flat 25 percent of their estimated losses—a figure the house fixed at 1 percent of the amount they were estimated to have wagered. But this was always very much a ballpark figure, he says. Now he comps at 25 percent of the amount their skill evaluations suggest they will lose, on average, multiplied by the exact amount they wagered. The 5,795 players cited by Mouchou were particularly skilled, so their projected average loss was just .63 percent. Previously, Mouchou would have comped them \$41,500—one-quarter of 1 percent of \$16.6 million. Instead, he comped \$26,145, one-quarter of .63 percent of \$16.6 million. Thus he saved nearly \$15,000 in comps. Since this was spread out among 5,795 players, each player's comp reduction was tolerable: less than \$3. (And as a side benefit, he can track his dealers and see which ones keep the momentum going, and which ones are sluggish.)

Now Mouchou is planning a marketing campaign based on El Dorado's new technology. Most casinos won't expend their pit-boss man-

power on low-stakes tables and thus don't issue comps to the players who frequent them. So the MindPlay tables give El Dorado a marketing edge. "We want to be able to comp \$5 players, \$10 players, that other properties don't ever track," Mouchou says.

These advantages were not lost on Mohegan Sun's Garrow. But he faced one final hurdle: the gamblers themselves, who—just like anyone else—can be suspicious of electronic surveillance. Richard LeBaron, a product manager at MindPlay, says the company's technology offers advantages to players, too. "Like any new technology, it takes time to be accepted with open arms," he says. "It's all in training dealers in handling questions that come from patrons. Patrons have felt their comps are never tracked properly. The patrons of a casino now have a better understanding that with the system, they are going to get comped accurately and fairly."

Today, Mohegan Sun just has two MindPlay tables, which it keeps in its dealer-training facility—a steel warehouse a short drive from the casino itself. But it will install 10 of the new tables in the casino next month. And Garrow is planning to cash in all of Mohegan Sun's chips—literally—in favor of a new batch that works with the MindPlay tables. The new chips won't be as expensive as RFID chips, but they will be made of extruded nylon, not clay. The nylon gives more sharply defined edge patterns, allowing the camera's pattern-recognition software to correctly identify them.

Mohegan Sun hasn't given up on RFID entirely. It's considering giving its customers special RFID tags they can put on their cars and installing tag readers on the road to the casino. When the high rollers with bad blackjack skills hit town, Mohegan Sun will know it before they even reach the valet parking. "We could have services available, credit-limit changes, or set up a gaming table in a particular area, or have a favorite drink or food ready," Garrow says. "We might be able to make your experience here at Mohegan Sun that much more special." As Mohegan Sun and other casinos—and indeed other businesses—identify cost-saving surveillance technologies that both work on a practical level and are accepted by consumers, you can bet they'll be installing them. **David Talbot**



# Why Microsoft Paused Halo 2

**THE DECISION:** Microsoft released Halo 2, the sequel to its highly successful video game Halo, a year later than customers expected. Though the delay disappointed gamers in the short term, it ensured a better product. It also bolstered the hold of the Xbox game console—part of Microsoft's bid for a place in our living rooms.

**H**ALO, THE REVOLUTIONARY video game pitting the “Master Chief” against a coalition of evil aliens, helped spark sales of Microsoft's Xbox game console when both products debuted in 2001. When the company announced in August 2002 it was creating Halo 2, the game was expected to be on the market by the 2003 holiday season. Instead, it would not be released until the 2004 holidays.

Programmers at Bungie Studios, one of Microsoft's in-house game studios, insisted they needed more time to make the game they envisioned. Halo is a “first-person shooter,” the kind of game that runs the risk of becoming repetitive. Halo avoided that pitfall thanks to a gripping storyline, excellent graphics and sound, and innovative game play. By early 2004, customers were clamoring for Halo 2, and their expectations ran high. “The successor to Halo really had to be amazing,” says Shane Kim, general manager of Microsoft Game Studios. “If we had rushed the game out, we would have had fewer single-player missions, fewer multiplayer maps, and a lot less polish in the graphics and game play.”

That argument alone may not have been enough to justify the delayed release. But Microsoft needed Halo 2 to be wildly successful for reasons beyond the revenues it might generate. That's because the video game market drives the game-console market, whose major players are Sony's PlayStation, Nintendo's GameCube, and Xbox. And whereas a third-party game maker such as Electronic Arts



will try to sell a high number of games across different platforms, Microsoft uses proprietary games to drive demand for the Xbox. As Kim explains, “The console with the best games will win.”

Jay Horwitz, a senior analyst with Jupiter Research, says his company's data lend support to Microsoft's approach. “When we ask customers the three most important considerations in the purchase of their next game console,” he says, “availability of the best exclusive games consistently ranks highly.” At the time of Halo 2's release, Sony was dominating the game-console market with its PlayStation 2, and Microsoft was eager to capitalize on the success of Halo to increase its console market share. A much improved Halo 2 would help in that effort.



## Microsoft

**FY 2004 revenues:** \$36.8 billion

**Employees:** 60,000

**Hours gamers had spent playing Halo 2 online as of mid-June:** 250 million

But the market for game consoles is about much more than games. Microsoft continues to develop its Media Center operating system, which allows a computer to be a TV, DVD player, photo editor, and digital jukebox—and the upcoming release of the Xbox 360 will make connecting to a Media Center PC even easier. As Bill Gates recently told CNET, “We didn't do Xbox just to do a video game; we did it to be part of our vision of the digital lifestyle.”

Of course, Microsoft delayed Halo 2 not just because it felt it had to, but also because it *could*. Microsoft doesn't face the same financial pressures that most other game companies do, and its strength allows it to base narrow decisions, such as release dates, on broad strategic goals. “Winning the console market is a marathon for them. It's not measured on a quarterly basis,” says Jupiter's Horwitz.

That said, Microsoft did see a short-term benefit from delaying Halo 2. When the game shipped, it was an instant success—in terms of both its own sales and those of the Xbox. According to the NPD Group, Halo and Halo 2 were both among the 10 top-selling video games of 2004, even though Halo 2 was released in November (Halo 2 brought in \$125 million the first 24 hours it was released). The new game won dozens of industry awards and helped drive two million people to Microsoft's online game site. All that helped Microsoft's Home and Entertainment (read: Xbox) Division close out the year with its first quarterly profit, of \$84 million on \$1.41 billion in revenue. In the first quarter of this year, however, the division lost \$154 million on \$593 million in revenue. Things could get back on track later this year, with the Xbox 360 scheduled to be released for the holidays.

It's tricky to draw lessons from Microsoft, which operates in a strategic universe all its own. But the Halo 2 story underlines a big question for any company deciding whether to ship an acceptable product on time or a better product late: is a delay justified by an imperative greater than the short-term sales of the product itself? That question gave Microsoft pause. **Julie Bick**

*Bick, now a freelance writer, worked in product management for Microsoft from 1990 to 1995; her husband works for the company now.*

By Invitation Craig Newmark

# Socialized Computing

The founder of craigslist is obsessed with customer service.

**M**Y TITLE AT craigslist is “customer service rep and founder,” and my customer service role is at least a full-time gig. A CEO runs the actual organization now. I’ve always had difficulty articulating why I have this obsession. I work anywhere from two to ten hours a day, seven days a week, doing stuff like deleting “bait and switch” posts from New York apartment brokers, moderating discussion boards, and sharing community suggestions with the team. If you e-mail me about the site, I’ll probably write back—quickly, too.

Craigslist was originally a very simple e-mail list for my friends, focusing on arts and technology events in San Francisco. People suggested doing more, like job and apartment listings, so I did that; then I got more feedback—so I did even more stuff. Today, craigslist helps people in more than 100 cities in 24 countries with everyday needs, like finding a place to live or getting a job or selling furniture. With nine million unique visitors a month, it’s a big site, though a simple one. We have a pretty good culture of trust and goodwill.

**A lot of my motivation derives from the name of our site; I take things personally. I plan to be doing customer service forever.**

I figure that reasonably good customer service is part of the social contract between producer and consumer. In general, if you’re going to do something, you should follow through and not screw around. As a nerd, I have the tendency to take things pretty seriously, so if I commit to something, I try really hard to stay committed.

This isn’t altruism or social activism; it’s just giving people a break. Pretty much all world religions tell us that one moral

value is to help other people if you can. I feel that customer service, even when you get paid for it, is an expression of that value, an everyday form of compassion.

Also, I’ve learned from the open-source movement that people want to contribute to endeavors of mutual benefit. So at craigslist, we’ve turned over a lot of control over the site to the people who use it. We seriously listen to suggestions and actually change the site in response to them.

Anyone who feels a posting on our site is wrong, for whatever reason, can flag it for removal; if enough people agree, the ad’s removed automatically. A similar philosophy is embodied in the Wiki movement, particularly in Wikipedia (an online encyclopedia whose roughly two million entries are created and corrected by the site’s users). We plan to turn over even more control of our site to the people who use it. Mainly, we need suggestions about what to do next.

Currently, we’re trying to figure out how to charge the New York rental agents for apartment listings (they’ve suggested this as a way to improve site quality) while giving a break to the smaller agents.

I feel that all this is a deep expression of democratic values. From a business point of view, of course, it makes good sense, too: it lowers our costs and improves the quality of what’s on our site. Finally, it helps keep management in touch with what’s real—or at least that’s what we hope.

Unfortunately, in contemporary corporate culture, customer service is often an afterthought, given lip service only.



**Craig Newmark** is a Web-oriented software engineer, with around 25 years’ experience of coding. In 1995, he started craigslist, a community bulletin board with classifieds and discussion forums. Today, tens of millions of people use the site for free. In high school, he really did wear a plastic pocket protector and thick black glasses, taped together.

This seems to be part of the general dysfunction of large organizations. As a company accumulates power and money, the people who are skilled at corporate politics take control of it. Customer service never seems to be highly prized by people with those skills. Maybe it’s because they lack empathy.

I speak with a lot of workers at many companies, and for the most part, they really want to provide good customer service. But they tell me they’re often prevented from doing so because service is seen as a cost and not something that contributes to profits.

Me, maybe a lot of my motivation derives from the name of our site; I take things personally. Maybe sometime this year I can go part time as a customer service rep, and I could use a day off, maybe a Sunday. But I plan to be doing customer service forever.

No matter how hard I try, sometimes we screw up. Then we apologize and fix it. My lingering concern is that I’m missing something big, and that I need to hear about it from my team and the community. What am I missing? ■





**Continuous computing:**  
the proliferation of cheap mobile gadgets,  
wireless Internet access for everyone,  
a new Web built for sharing and self-expression...  
suddenly, computing means *connecting*.

# Social Machines

MY BOSS, JASON PONTIN, CAUSED A MINOR RUCKUS IN MAY while attending D3, the *Wall Street Journal's* third annual "All Things Digital" conference outside San Diego. The editor in chief of *Technology Review*, like many executives, entrepreneurs, engineers, and students these days, doesn't go anywhere without his wireless gear—meaning, at a minimum, a Wi-Fi-enabled laptop and a cell phone. At D3, Jason was using his laptop to file blog (or Web log) posts "live" from the conference floor, summarizing talks by Bill Gates, Steve Jobs, Sun Microsystems CEO Scott McNealy, and other computer-industry celebrities. But on the third day, he couldn't find a signal. The Wi-Fi network he'd been accessing was on by mistake, a conference staffer

Editor's note: In this article, additional comments and references appear in the margins. Most were written by the author. However, several were contributed by visitors to the article's companion blog, [www.continuousblog.net](http://www.continuousblog.net), where a draft of the article was published in May. This experiment in online participatory journalism seemed appropriate in light of the article's subject: social computing. The blog will be maintained indefinitely as a forum for discussion of this theme.

By Wade Roush  
Illustration by Peter Stemmler

**Blog post:** See [pontin.trblogs.com/archives/2005/05/d3\\_suppressing.html](http://pontin.trblogs.com/archives/2005/05/d3_suppressing.html).

**Other bloggers:** Including me. See [www.continuousblog.net/2005/05/disconnected\\_at.html](http://www.continuousblog.net/2005/05/disconnected_at.html).

**Continuous partial attention:** A phrase coined by Linda Stone, a former Microsoft vice president and a widely respected authority on human-computer interfaces.

**Wikis:** Web pages that allow users to add content or edit existing content.

**Podcasts:** Amateur radio shows without the radio. Podcasters produce MP3 recordings on whatever subjects interest them and publish the files on the Internet, where listeners can subscribe to shows, download files to their computers, and then transfer them to their portable music players, such as the Apple iPod.

**Flickr:** The photo-sharing site of choice for many digital photographers. One of its trademark features is the ability to add descriptive words, or “tags,” to photographs, so that the photographer or others can find them more easily later. See [www.flickr.com](http://www.flickr.com).

**Delicious:** A “social bookmarking” site created by freelance software developer Joshua Schachter. Users can store URLs, personal comments, and descriptive tags that will help them identify Web pages they want to find later. See [del.icio.us](http://del.icio.us).

told him. She explained that the hosts of the conference—Walt Mossberg and Kara Swisher, two of the *Journal's* technology writers—had decided that no one should have Internet access from the main ballroom.

Jason, naturally, wrote a new [blog post](#) about the incident (from the hallway this time). Forbidding live blogging at a technology conference, he remarked, “seems a very retrograde move.” Mossberg responded hours later. “It is untrue that Kara and I banned live blogging at D3, from the ballroom or anywhere else,” he explained. “We merely declined to provide Wi-Fi, to avoid the common phenomenon that has ruined too many tech conferences—near universal checking of e-mail and surfing of the Web during the program.”

[Other bloggers](#) soon pounced on the minicontroversy. Some commended Mossberg's decision and warned against the perils of “[continuous partial attention](#),” the state of mental blurriness thought to be induced when information is constantly pouring in from multiple sources. Others extolled the social benefits of “always on” connectivity. “During conferences the back channel can and does enhance the fore channel, especially if I'm able to look up information that would be too tedious, basic, or digressive to ask about during a Q&A,” wrote Gardner Campbell, an assistant vice president for teaching and learning technologies at the University of Mary Washington in Fredericksburg, VA. “I can also share the experience, and be newly energized, by being in touch with staff and friends and family who are not able to attend with me.”

Both sides had a point. But the most telling thing about the debate was that it happened at all. Without much hoopla, many conference centers and university and corporate campuses—even entire metropolises, in the case of Philadelphia and a few other cities—are being turned into giant Wi-Fi hot spots. Trains, planes, airports, and libraries are also installing wireless networks to serve customers carrying wireless gadgets. As a result, many businesspeople, students, and Starbucks addicts now expect cheap, easy access to the Internet as a matter of course. Losing it can feel like being stranded.

Constant connectivity has changed what it means to participate in a conference or any other gathering. Using chat rooms, blogs, [wikis](#), photo-sharing sites, and other technologies, people at real-world meetings can now tap into an electronic swirl of commentary and interpretation by other participants—the “back channel” mentioned by Campbell. There are trade-offs: this new information stream can indeed draw attention away from the here and now. But many people seem willing to make them, pleased by the productivity they gain in circumstances where they'd otherwise be cut off from their offices or homes. There is meaning in all of this. After a decade of hype about “mobility,” personal computing has finally and irreversibly cut its bonds to the desktop and has moved into devices we can carry everywhere. We're using this newly portable computing power to connect with others in ways no one predicted—and we won't be easily parted from our new tools.

## Continuous Computing

To grasp how rapidly things are changing, consider all the things you can do today that would have been difficult or impossible just a few years ago: you can query Google via text message from your phone, keep an online diary of the Web pages you visit, download [podcasts](#) to your iPod, label your photos or bookmarks with appropriate tags at [Flickr](#) or [Delicious](#), store gigabytes of personal e-mail online, listen to the music on your home PC from any other computer connected to the Net, or find your house on an aerial photograph at Google Maps. Most of these applications are free—and the ones coming close behind them will be even more powerful. With more and more phones carrying Global Positioning System (GPS) chips, for example, it's likely that companies will offer a cornucopia of new location-based information services; you'll soon be able to find an online review instantly as you drive past a restaurant, or visit a landmark and download photos and comments left by others.

This explosion of new capabilities shouldn't be mistaken for “feature creep,” the accretion of special functions that has made common programs such as Microsoft Word so mystifyingly complex. There is something different about the latest tools. They are both



digital, rooted in the world of electrons and bits, and fundamentally social, built to enable new kinds of interactions among people. Blogging, text messaging, photo sharing, and Web surfing from a smart phone are just the earliest examples. Almost below our mental radar, these technologies are ushering us into a world of what could be called *continuous computing*—continuous in the usual sense of “uninterrupted,” but also in the sense that it’s continuous with our lives, in all their messy, social, biographical richness.

The arrival of continuous [computing](#) means that people who live in populated areas of developed countries (and increasingly, developing ones such as China and India) can spend entire days inside a kind of invisible, portable “information field.” This field is created by constant, largely automated coöperation between

- 1) the digital devices people carry, such as laptops, media players, and camera phones
- 2) the wireline and wireless networks that serve people’s locations as they travel about, and
- 3) the Internet and its growing collection of Web-based tools for finding information and communicating and collaborating with other [people](#).

This information field enables people to both *pull* information about virtually anything from anywhere, at any time, and *push* their own ideas and personalities back onto the Internet—without ever having to sit down at a desktop computer. Armed with nothing more than a smart phone, a modern urbanite can get the answer to almost any question; locate nearby colleagues, friends, and services; join virtual communities that form and disband rapidly around shared work and shared interests; and self-publish blog entries, photographs, audio recordings, and videos for an unlimited audience.

The ingredients of continuous computing have emerged piecemeal. Japanese companies, for example, have long been testing new social and personal uses for cell phones. Model [smart homes](#) that demonstrate how intelligent appliances will converse with each other are a perennial favorite in both Japan and the United States. But the final pieces fell into place only recently. These include the spread of Wi-Fi and other types of wireless access to millions of offices, homes, airports, and cafés; the enormous popularity of camera phones and mobile audio players; free or inexpensive voice-over-Internet phone calling; the rise of blogs as a means of both personal and political communication; personal and professional social-networking sites; tagging and social bookmarking; collaboration tools such as wikis and Microsoft’s Groove Virtual Office; new tools for gathering chunks of media “microcontent” into something resembling a personalized electronic newspaper; location-based services and other applications tied to specific geographic coördinates; and new computer languages and standards that make it easy to offer powerful, personalized software services over the Web. What makes all these tools different from the computing styles of the past is that they fit more naturally into our real lives—meaning, for example, that they adapt more readily to our locations, our preferences, and our schedules.

One analyst who writes about these issues is Alex Pang, a historian of science and former managing editor of the *Encyclopædia Britannica* who now works as a research director at the Institute for the Future, a Palo Alto, CA, think tank. Software engineers, he says, have discovered that computer science’s decades-long effort to make computers

smart enough to understand humans is simply irrelevant; they can make computing truly personal and social using simple Web-based programming tools. After all, we don’t really want to talk *with* computers—we want to talk *through* them. “The brilliance of social-software applications like Flickr, Delicious, and [Technorati](#),” Pang says, “is that they recognize that computers are really good at doing certain things, like working with gigantic quantities of data, and really bad at, for example, understanding the

**Computing:** Blog reader Hannu Leinonen comments: “I feel uneasy about the word ‘computing.’ It sounds like counting. In Spanish the word for computer is ‘ordinador’ and in Finnish it’s ‘tietokone.’ Tietokone translates to ‘knowledge machine.’ We are not there yet, but have we passed computing?”

**People:** Blog reader Gene Becker comments: “In your definition of continuous computing, you might consider adding ‘4) and the devices they encounter along the way, such as situated displays, networked entertainment systems, printers, and connected vehicles.’ We are just around the corner from these situated networked devices’ becoming active participants in our digital experience. I wonder if you also want to pull in physical-tagging notions (RFID, bar codes, semacodes, visual tags, etc.) as the ‘physical hyperlinks’ that bring everyday objects into the digital mix. In the same spirit, GPS and other location technologies are starting to make physical place a first-class element of the digital experience. Oh, and can we all please work on a better term, one that doesn’t use ‘computing’? It’s so *not* about that.”

**Smart homes:** A leading example in the United States is the Georgia Tech Broadband Institute Residential Laboratory, a three-story home outfitted with people-tracking sensors, gesture-sensitive remote controls, and other widgets. Part of the Aware Home Research Initiative funded by Hewlett-Packard, Intel, Motorola, and the National Science Foundation, the Residential Laboratory is a classic instance of computing research that starts with a perceived need—assisting the elderly with complex, information-intensive tasks, for example—and invents gadgets and software that supposedly address the need. But as we’ll see, continuous computing is an emergent phenomenon—a complex pattern of social behaviors that arises from the use of a variety of simpler digital tools. It advances in unexpected directions as people find innovative ways to put these commercial and open-source technologies to use in their social lives.

**Technorati:** A search engine built by software developer David Sifry that scans millions of blogs and displays the most recent posts relating to any given keyword or tag.



Alex Pang

COURTESY OF ALEX PANG

different meanings of certain words, like ‘depression.’ They devote computing resources in ways that basically enhance communication, collaboration, and thinking rather than trying to substitute for them.”

### The Computer That Wouldn't Disappear

While continuous computing is now a practical reality, it has been a long time coming. The first serious work on it began 17 years ago at Xerox's famed Palo Alto Research Center (PARC). That's where computer scientist Mark Weiser set out to study the notion of **ubiquitous computing**, which he defined as “activating the world”—creating networks of small, wireless computing devices that permeated the physical structures around us, where they would supposedly anticipate our needs and act without requiring our attention. Weiser's earliest experiments, funded by the U.S. Department of Defense, involved a network of infrared sensors scattered around PARC. The sensors communicated with prototype “tabs”—small, wireless displays that functioned as labels or sticky notes—and with tablet-sized handheld computers and large display boards. Weiser envisioned hundreds of these devices installed in rooms, homes, and office complexes, where they would eventually become “invisible to common awareness,” as he predicted in a 1991 article for *Scientific American*. “People will simply use them unconsciously to accomplish everyday tasks,” he wrote.

Tragically, Weiser died of cancer in 1999, at age 46. But by then, others had taken up his call, including the famed product-design consultant Donald Norman, who squeezed an entire thesis into the title of his 1998 book, *The Invisible Computer: Why Good Products Can Fail, the Personal Computer Is So Complex, and Information Appliances Are the Solution*. People might be more efficient if their spaces, work flows, and communications were fully digitized, but this wouldn't happen until improved technology relieved them of the sense that they were interacting with “computers” at all, Norman argued. He called for a new generation of “information appliances” that would facilitate specific activities—such as teleconferencing, shopping, photography, or exercise—without calling attention to themselves. Echoing Weiser, Norman wrote that these appliances would “become such an intrinsic part of the task that it will not be obvious that they are there. They will be **invisible** like the embedded processors in the automobile or microwave oven.”



Donald Norman

Researchers got busy building these appliances at places like MIT's Laboratory for Computer Science and Artificial Intelligence Laboratory (since folded into one large lab). In 2000, the lab launched a five-year, industry-funded initiative called **Project Oxygen**, so named because the founding scientists believed that computation would eventually be “freely available everywhere, like batteries and power sockets, or oxygen in the air we breathe.” Like Weiser, the Oxygen researchers have focused on a combination of handheld devices and networks of sensing and communications equipment embedded in the environment—cameras, microphones, displays, wireless transmitters and receivers, and the like. Their most famous prototype is the Intelligent Room, a conference room rigged with sensors and displays that responds to voice commands, saves audio records of users' discussions, and calls up presentations or recordings of prior meetings. The idea, according to the MIT researchers, is to automate as many aspects of human collaboration as possible.

Ubiquitous-computing research continues at PARC, where researchers are working on technologies such as embedded sensors trained to zero in on specific conversations in busy rooms so that people watching by videoconference can join in. And in Europe, a three-year, \$28 million “Disappearing Computer” initiative from 2001 to 2003 resulted in several ongoing projects on “ambient computing,” the idea of augmenting everyday objects with small, wirelessly networked sensors.

But here's the surprise: the tools that are actually bringing us continuous computing aren't invisible. In fact, they are the very technologies Weiser and his successors were trying to sideline: off-the-shelf computing devices such as laptops and **cell phones**, both

**Ubiquitous computing:** Weiser's original Web pages on the subject are preserved at [www.ubiq.com/hypertext/weiser/UbiHome.html](http://www.ubiq.com/hypertext/weiser/UbiHome.html).

**Invisible:** Blog reader Gardner Campbell comments: “These are compelling essays and concepts, but a small worry persists: will the grail of invisible, continuous, ubiquitous computing turn out to be a cognitive deadener, too? Some things work best when they're visible and a little recalcitrant: writing, for example, or thinking, for another example. If we use symbols effortlessly, there's a risk we'll settle for the path of least resistance automatically rather than go for the more ambitious and difficult goals, the computer equivalent of a set of grunts and gestures instead of a language, which involves a fair amount of work to acquire and use well but has rich payoffs in terms of semantic density.”

**Author's response:** I agree. That's why I point out in this section and elsewhere that continuous computing is *not* about making computers invisible.

**Project Oxygen:** See [oxygen.lcs.mit.edu/Overview.html](http://oxygen.lcs.mit.edu/Overview.html).

**Cell phones:** They're now constant companions for 1.7 billion people worldwide. According to market research firm IDC, more than 690 million phones were shipped in 2004 alone. In the first quarter of 2005, vendors shipped 8.4 million “converged mobile devices,” meaning phones that also function as PDAs and can run many types of software applications—an increase of 134 percent over the first quarter of 2004. More than 182 million people in the United States subscribe to cellular services, and in 2004 they spent more than a trillion minutes using their phones.

of which allow users to tap into Web-based social-software systems built in a largely unplanned way by people using common programming languages and shared, open communications protocols and development tools. These systems don't have to be designed as unified, integrated systems, like Project Oxygen's Intelligent Room, in order to be useful tools for social computing; they can just as well emerge from the bottom up, the way peer-to-peer networks and the Web itself did. (Indeed, one reason that projects at PARC, Project Oxygen, and other labs have never really blossomed into commercial systems may be that they are [too heavily engineered](#) for preconceived uses.) And we don't really need computers to disappear into the woodwork, or to have elaborate spoken-word interfaces. In fact, today's social-software boom rests on common devices such as mobile phones, computers, digital cameras, and portable music players.

"One of the things that really blew my mind was a trip last year at Christmastime to a mall in the DC suburbs," says [Thomas Vander Wal](#), an Internet-application designer whose writings are widely followed by developers of social-software applications. "Which is, as places go, a little bit more technically advanced than the more rural areas at the center of the U.S., but it's still not the Bay Area or New York. But I was seeing people 50 and older waiting in line to get their packages wrapped and staring at their mobile devices. I don't know if they were text-messaging their kids or browsing the Web or what, but their mobile devices were being used for more than just calling somebody. It was at that point that I thought, 'We're almost there'—wherever 'there' is."

## The Enabling Technologies

Three broad technology trends are making computing continuous. The first, as noted earlier, is easy, inexpensive Internet access. The second is the spread of inexpensive, wireless computing devices. Above all, this means wireless laptops. Only a computer capable of running a full-blown Web browser allows access to the full range of Web-based software applications, which are, as we'll see in a moment, the third major source of technologies making computing more social. But laptops can't be carried everywhere, and smaller devices such as digital cameras, video recorders, voice recorders, portable CD and DVD players, MP3 players, PDAs, pagers, GPS receivers, and wearable gear like Microsoft's wireless SPOT (for "Smart Personal Object Technology") watches have the important function of maintaining the information field when there isn't a computer at hand. Then, of course, there's the smart phone—in essence, a miniature computer juggling tasks that formerly required half a dozen [separate devices](#). The smart phone is "an ideal system for pervasive, supportive social computing," writes Russell Beale, director of the Advanced Interaction Group in the computer science department at the University of Birmingham, England. It's "a two-way device, creating and consuming information, is highly personal, and is almost always available..."

The third trend nudging us into a new era of computing is probably the most important and the least expected. It is the emergence of the Web as a platform for personal publishing and social software. The examples are as diverse as informational sites such as blogs, craigslist, and [Wikipedia](#) and services such as Gmail, LinkedIn, Flickr, and Delicious. All of these are examples of what software developers and Internet pundits have begun to call "Web 2.0": the transformation of the original Web of [static documents](#) into a collection of pages that still look like documents but are actually interfaces to full-fledged computing platforms. These Web-based services are proliferating so fast because they can be built using shared, standardized programming tools and languages developed, for the most part, by the open-source-software community.

The list of popular social-software applications is almost overwhelming. The oldest examples include text messaging on phones and pagers, instant messaging between computers, and good old e-mail. But while these technologies may be familiar, they are being radically upgraded to work with the Web. Classic circuit-switched landline and cellular telephony, for example, faces growing competition from packet-switched systems, including Voice-over-Internet-Protocol (VoIP) networks such as Vonage and Skype. Calls placed within Skype's peer-to-peer network are free, which has made the service a favorite among startup companies with employees in far-flung locations. Adam

**Too heavily engineered:** Blog reader Gene Becker comments: "I agree with your assessment and would add that in many cases, they are technology solutions in search of a problem. What is the question to which 'ubicom' is the best answer?"

**Thomas Vander Wal:** Best known for popularizing two concepts, the "infocloud" (the aggregate of one's personal digital data, which increasingly resides on networks rather than on desktop PCs or permanent media) and "folksonomies" (the knowledge structures that emerge in place of hierarchical taxonomies when groups of people tag digital data using an unconstrained vocabulary).

**Separate devices:** PalmOne's Treo 650, for example, is styled like a phone but also acts as a still and video camera, an e-mail and instant-messaging platform, an MP3 player, a game player, a personal organizer, a Web-browsing device, an e-book reader, and a short-range communicator (using the Bluetooth wireless standard).

**Wikipedia:** An online encyclopedia built using wiki software, meaning that anyone may add entries or edit existing ones. With 1.8 million articles written by 51,000 contributors in 109 languages, it is the world's most comprehensive (though perhaps not its most reliable) reference work. It may, in fact, be the largest collaborative literary work in history. (See "Larry Sanger's Knowledge Free-for-All," January 2005.)

**Static documents:** Web 1.0 consisted largely of text files jazzed up with browser-readable HTML instructions on how to display the text and where to find related files. Web 2.0 is more like a collection of programs that talk to one another.



Curry, a former television-show host on MTV who coined the idea of podcasting, gushes frequently about Skype in his own podcasts, saying it's the main way he conducts business at Podshow.com, a podcasting network he is launching soon. "Skype is going to be *the* phone company," Curry intones.

Wi-Fi cell phones that let people use Skype even if they're away from their computers may soon hit the market, and new techniques for handing active calls from a cellular network to a Wi-Fi network will allow people with dual-band phones to switch to the lowest-cost service available at any given location. Meanwhile, the Short Messaging System (SMS) for text messaging is giving way to the Multimedia Messaging System (MMS), which can handle pictures, sound, and video in addition to text. Then there's Google's Gmail service, which offers a practically unlimited amount of storage online and an extremely efficient search mechanism for rummaging through it. Some users consider Gmail to be at least as powerful as client-side e-mail programs such as Outlook and Eudora (which store e-mail locally on a desktop machine), with the added advantage that it is accessible from any computer with a browser.

Tools that turn private individuals into Internet broadcasters are another booming application. When blogs were first emerging, publishing one was a tedious and forbidding process that involved rewriting HTML code and manually uploading files to a Web-hosting service. But with the advent of Blogger, LiveJournal, Movable Type, WordPress, and other services, the task of blog publishing has been reduced to writing something cogent and clicking on a couple of buttons. As a result, blogs have become the personal launching pads for millions of Web users' social activities online—the place where they gather their own thoughts and artistic creations, invite others to react, and share links to and commentary about content they find elsewhere on the Web. Lately, it's become cheap and easy to publish audio and video blog entries. And new tools for transferring audio blog posts to portable digital-music players like the Apple iPod have created a platform for **podcasting**, an entirely new form of personal publishing. In 2004 there were only a handful of regular podcasts; now there are several thousand, ranging from the sexually graphic "Dawn and Drew Show" to "The Catholic Insider," in which Father Roderick Vonhögen, a priest of the Archdiocese of Utrecht, the Netherlands, ruminates on the new pope, run-ins with airport security guards in Rome, and *Revenge of the Sith*.

But bloggers and podcasters wouldn't have much to publish without a constant stream of incoming information, and another set of Web technologies is helping Internet users to personalize that stream. Even before the Web, futurists predicted the advent of the personalized newspaper. Nicholas Negroponte, the founding director of the MIT Media Lab, called it "The Daily Me," a collection of items plucked from a variety of media outlets by your home's main computer, which would supposedly learn your preferences by watching what you read and what you ignore. But Negroponte's future has arrived: one of the most earthshaking developments in information management in the past half-decade is a straightforward Web-programming hack called **RSS**. It's a way of packaging Web items such as blog entries in a stripped-down, XML-based format so that they can be imported into other Web pages. Most blog-hosting services automatically create RSS versions of blog posts. That means bloggers can "syndicate" their content across the entire Web, while readers can subscribe to RSS **feeds** from all of their favorite blogs or news sites, and view them in a single place using an "aggregator" service such as NetNewsWire, NewsGator, or Bloglines. These services make it easier than ever for people to monitor developments in their areas of interest. (On the downside, perhaps, aggregators also allow people to filter out news and ideas that don't accord with their views.)

The most radical ideas in Web-based software, however, are flourishing in an area that might be called "social knowledge management," represented in part by sites like Friendster, LinkedIn, and Ryze. Such **social-networking sites** generated a wave of venture investment and new users in 2004. At their best, they are like human search engines: they exploit the "six degrees of separation" concept to help people make connections with friends of friends of friends who may share similar interests or business goals. Now a twist is on the way: a Boston startup called Proxpro is testing a cell-phone-based service whereby a traveling businessperson can register a change in

**Podcasting:** Podcasters don't agree on much about their craft—both Adam Curry and software guru Dave Winer claim to be the technology's godfathers, for example—but they do seem to agree that the term "podcasting" was coined by Ben Hammersley, a writer for British newspaper the *Guardian*, in an article published February 12, 2004.

**RSS:** There is some contention over who invented RSS and what the name actually stands for. In 1999, as part of the World Wide Web Consortium's effort to build a Resource Description Framework (RDF) to support Tim Berners-Lee's concept of the Semantic Web, engineers at Netscape created a document-mining tool called "Rich Site Summary," but they abandoned it in 2001. Meanwhile, programmer Dave Winer wrote a script for publishing chunks of one site's content on another, and called it "Really Simple Syndication." This is now the most commonly accepted meaning of RSS, but the Netscape definition still has its proponents, and still others say RSS stands for "RDF Site Summary."

**Feeds:** An RSS feed can be created for just about anything. RSS is a key technology behind podcasting, which is essentially a method of delivering audio files via RSS subscriptions. And social-bookmarking services such as Delicious and Rojo let users subscribe via RSS to the links their friends save and annotate as they voyage around the Web.

**Social-networking sites:** See "Internetworking," April 2004.

location with an SMS message; if a potential contact who matches the traveler's pre-specified areas of interest (say, Oracle databases) is nearby, both parties are notified, and they can use SMS to arrange a meeting.

The social-networking sites, in fact, were only a preview of what Web 2.0 technologies will make possible. Using a few basic building blocks such as XML, open-source database software, simplified programming languages and environments like Ruby on Rails, and protocols, like SOAP and REST, for exchanging data between Web applications, Web developers can build elaborate yet practical "social services" that collect and redistribute the knowledge of large communities of people. (See the box on page 52 for a tour of some of the most interesting new services.)

The more people who use the new services, the **more powerful** those services become. That's because they're all about coöperation: people are usually happy to share their knowledge, experiences, creations, schedules, and locations if it means that they can learn what the people who are important to them are thinking and doing. The most successful services are always about shared interests; Jyri Engeström, a PhD student in the Department of Organisation, Work, and Technology at the Lancaster University Management School in Britain, calls this the rule of "object-centered sociality." "The fallacy is to think that social networks are just made up of people," Engeström wrote in a much-cited entry on his blog, Zengestrom.com, in April. "They're not; social networks consist of people who are connected by a shared object," such as the photographs they upload to Flickr, the URLs they bookmark at Rojo or Delicious, or the articles they write for Wikipedia. Of course, social software can also be put to less community-minded uses: the same Internet-based services that keep businesses and families connected can be used to arrange casual sexual encounters, distribute pornography, or run **terrorist networks**. But in a way, the fact that the technology can support the full spectrum of human enterprises—whether socially productive or not—only underscores its power.



Jyri Engeström

## Computing /s Real Life

It's clear that new technologies are making computing continuous—meaning both "always on" and "smoothly shading into our real lives." But what's actually new about the experience of continuous computing? How is life changing for those with the **money** to buy a few mobile devices and the time to sign up for Web-based social services?

At bottom, the shift is bringing computing far closer to our everyday experience. We've just seen how social software can give us new ways to tap into the collective wisdom of the people in our social groups. But that's only one consequence of continuous computing. On a more personal level, for example, the portable devices that sustain the information field are more respectful of our *bodies* and our perambulatory nature. No longer do we have to slouch over desktop computers all day to stay connected to the Net: computing devices have become so small, light, and ergonomic that we can take them **almost everywhere**. Visit any airport, beach, or city park and you'll see people carrying laptops, cell phones, and dedicated devices such as cameras and music players as naturally as if they were part of their clothing. For people who must take their cell phones absolutely everywhere, there are even "ruggedized" devices like Motorola's new i355 handset, which meets U.S. military specifications for resistance to dust and blowing rain.

Mobility, in turn, has created a demand for software that's sensitive to our ever-changing *locations*. Already, many cell phones sold in the United States contain systems such as GPS receivers that report users' whereabouts during 911 calls. So far, few carriers have created ways for third-party software developers to put this location information to other uses, but in time, navigation tools and automatic-access location-specific shopping or dining information will become standard fare for cellular subscribers. In this area, Japanese and South Korean companies are, as usual, showing the way. Tokyo-based cellular provider KDDI, for example, sells phones that use GPS and onscreen maps to guide urban pedestrians to their destinations.

**More powerful:** This is one manifestation of Metcalfe's Law, the observation by Ethernet inventor (and *Technology Review* board member) Bob Metcalfe that the value of a network increases as the square of the number of nodes in the network.

**Terrorist networks:**  
See "Terror's Server," February 2005.

**Money:** It must be said that in many parts of the globe, low incomes and political restrictions mean that citizens are very far from achieving a state of continuous computing. At the same time, however, cellular networks cover an increasing portion of the planet, efforts such as Nicholas Negroponte's Hundred-Dollar Laptop project may bring cheap computing to many markets currently underserved by major manufacturers, and countries without an entrenched infrastructure of landline telephones are often leapfrogging to broadband wireless networks.

**Almost everywhere:** There is, however, one limitation still tethering us to the grid: battery power. Even today's best nickel-metal-hydride, lithium-ion, and lithium-ion-polymer batteries will keep a laptop running for only eight to 10 hours, and a cell phone for about five hours (assuming continuous talk). Compact fuel cells could quintuple these times, but they aren't expected to be widely available until 2010.

# Your Life, Online

## Surveying social software on the Web

### **Backpack ([www.backpackit.com](http://www.backpackit.com)):**

An information organizer accessible from Web browsers and smart phones that lets users make lists, create reminders, store files and photos, and share any or all of this content with selected associates or family members. Created by 37signals, a Chicago-based software consultancy.

### **Dodgeball ([www.dodgeball.com](http://www.dodgeball.com)):**

A friend-finder service mediated by text messages. Members in 22 U.S. cities use SMS to alert the Dodgeball network to their locations; the network broadcasts a member's location to the phones of nearby friends, friends of friends, and "crushes." Google acquired Dodgeball in May.

### **Eurekster ([www.eurekster.com](http://www.eurekster.com)):**

A social-search engine. Everyone who uses the Eurekster search box at a particular site becomes a member of a local "search party"; feedback from party members about the relevance of each search result is used to give the best results higher rankings in future searches.

**EVDB ([www.evdb.org](http://www.evdb.org)):** The Events and Venues Database. A free, searchable repository for notices of events taking place around the world. Anyone can register an event.

**Little sense:** Blog reader Erik Karl Sorgatz comments: "I disagree to the extent that there is an old maxim about the system: 'If you build it...they will hack it!' Disguise, deception, and outright identity theft are also amplified by the very same tools that can bring us together in our creative phases. In some ways, this dependence upon a technology-based infrastructure makes us both stronger *and* weaker. It might be better to blend this all with a little self-reliance, some non-computer-based learning, a little apprenticeship involving real mechanical skills—they don't even teach the kids shop classes anymore."

**Patterns:** Blog reader Ian Wells asks, "How do we teach ourselves and our children to develop a rhythm of communication that is helpful to our relationships and our human pace of life? What patterns of communication will drive us crazy? What helps our families? What helps our relationships? Why do so many people spend so much time watching TV instead of doing something active with real people? We had part of the same issue with cheap phone calls, with continuous TV, with broadband Internet. Now we go up a level of choice. Because we can communicate continuously, should we? What do conscientious parents teach their children about healthy continuous computing? Are there healthy limits?"

**Futuristic gadgets:** Blog reader Jim Haye comments: "Very interesting, but I'm surprised at the lack of coverage of the devices we interact with each day that have the most computing power of all—automobiles. The typical car today has numerous microprocessors operating over several networks and runs incredibly complex software in a highly risky environment. Sure, you don't carry them in your pocket, and they're transparent to most users, but automotive information systems are a big computing application."

The new technologies also allow people to create more-detailed, true-to-life online *identities*. A decade ago, it was common for consumers opening online accounts to disguise themselves behind fanciful usernames like "Sk8rdude." But today it makes [little sense](#) for a blogger or a member of a photo-sharing or social-networking community to stay anonymous; after all, taking personal credit for the viewpoints we express or the creations we share is often a way of gaining clout and attracting new acquaintances.

The best continuous-computing applications also mesh with our lives by understanding our *preferences*. Think of Amazon.com's recommendation engine, which suggests products based on the purchase histories of other customers with similar tastes. Newer Web tools apply the same idea to other types of content; for example, Bloglines, owned by search company Ask Jeeves, analyzes a user's RSS subscriptions to come up with a daily list of new feeds that might be of interest. The creators of Backpack, meanwhile, built in many ways for users to adjust the site's behavior to their needs. For example, users can publish files and to-do lists from their cell phones if they aren't at a computer, make their pages public or restrict them to specified associates, and program the system to send SMS reminders to their phones at general times like "next Tuesday" or at specific moments like "30 minutes from now."

Which leads to a final feature of continuous-computing technologies: they adapt to the *chronology* of our lives. Shared calendars like EVDB and Upcoming make it easy to synchronize our activities with those of our friends and colleagues. Soon, our mobile devices may even track our activities, extract [patterns](#), and predict what information or services we need at specific times of day. That's an area being explored by Nathan Eagle, a postdoctoral student at the MIT Media Lab. "There are patterns in when you go to Starbucks, when you go out to the bar, and when you call your mom, to the point that you can start predicting what the person is going to do next," Eagle says. A phone sensitive to your schedule and your location might realize, for example, that the office is always your next stop after the coffee shop and would start gathering your e-mail and voice-mail messages from the Internet as you take your first sip of latte.

Of course, you don't need [futuristic gadgets](#) like this to create a personal information field. Just look at Ross Mayfield, CEO of Socialtext, a company that sells Web-based collaboration software based on wikis. The 34-year-old serial entrepreneur lives in Palo Alto with his wife and two children. Until Socialtext obtained venture-capital funding this spring, Mayfield's office was entirely virtual. But even though the company now has a real headquarters, Mayfield still carries a small armory of digital devices around with him, including a Treo 600 smart phone, a 17-inch Macintosh PowerBook G4 laptop ("It sounds like it wouldn't be portable, but it is," he says), an Olympus 5060 digital camera, an Apple iPod with an iTalk attachment for recording voice memos, a Jabra wireless headset, a Wi-Fi network detector, an Apple Airport Extreme Wi-Fi base station, a USB memory key, and, of course, the obligatory tangle of power cords and chargers.



### 43 Things ([www.43things.com](http://www.43things.com)):

A collaborative goal-setting network. Members list up to 43 life goals, then consult others with the same goals for encouragement and commentary. One common goal: "Stop procrastinating."

**Ourmedia ([www.ourmedia.org](http://www.ourmedia.org)):** A free repository for digital media such as video, music, photos, text, and audio clips. Ourmedia's backers, including the Internet Archive, have promised to store users' files forever and provide unlimited bandwidth for downloads.

### Upcoming ([www.upcoming.org](http://www.upcoming.org)):

Another collaborative calendar. Members can enter the events they plan to attend, comment on events entered by others, and syndicate event listings to their blogs.

**Phling ([www.phling.com](http://www.phling.com)):** A peer-to-peer system that lets owners of Nokia smart phones send multimedia "post-cards" to their buddies, their blogs, and their home computers.

**Rojo ([www.rojo.com](http://www.rojo.com)):** A hybrid news aggregator, social network, and social-

bookmarking service. When a member finds an item of interest, she can store it and share it within her circle of friends and colleagues.

**Wikicities ([www.wikicities.com](http://www.wikicities.com)):** A free tool for creating community wikis on any subject. One Wikicity, for example, contains information on lucid dreaming, while another focuses on economic development in St. Petersburg, FL. Operated by Wikia, a startup founded in 2004 by Jimmy Wales, cocreator of Wikipedia.

Together, these devices ensure that Mayfield is never out of touch with his colleagues or his family. For one-to-one communications, Mayfield says, he uses the Treo, Skype's free VoIP service, and the e-mail system built into Socialtext's own software. To conduct company meetings and client calls, he uses the conference-calling services at FreeConference.com. When he's at a convention, a hotel, or a rented meeting room,



Ross Mayfield

he connects the Airport to the local network, which creates his own Wi-Fi zone and gives him access to the Web, Skype, instant-messenger software, and his company's [always-on](#) IRC channel. He also advertises his whereabouts by registering his temporary Wi-Fi zone with a service called [Plazes](#) and by describing on EVDB the events he's attending. He uses Movable Type and TypePad to maintain multiple blogs, including one for

his employees, one for the public, and several restricted to his customers. He bookmarks interesting Web pages on Delicious and sends them out on his personal link feed, titled "Linkorama." He reads the news and follows his favorite blogs using the NetNewsWire and NewsGator RSS aggregators, which also supply him with regular podcasts. Almost daily, he uploads photos from the Treo and the camera to Flickr, where anyone can view his photo stream. He even has a dedicated wiki for his family.

Though Mayfield is a self-confessed early adopter, he isn't using all these social-computing technologies just for the sake of [being wired](#). They're "rewarding in all kinds of ways," he says. He uses Skype to save money on long-distance calls; he announces his location to increase the chances of meeting useful business contacts; he posts photos on Flickr because he wants his family and his friends to know what he's been up to; and he blogs because it's an efficient way to keep his employees up to date, care for his customers, and get his message out to the larger world.

And this, in the end, is what's truly new about continuous computing. As advanced as our PCs and our other information gadgets have grown, we never really learned to love them. We've used them all these years only because they have made us more productive. But now that's changing. When computing devices are always with us, helping us to be the social beings we are, time spent "on the computer" no longer feels like time taken away from real life. And it isn't: cell phones, laptops, and the Web are rapidly becoming the best tools we have for staying connected to the people and ideas and activities that are important to us. The underlying hardware and software will never become invisible, but they will become less obtrusive, allowing us to focus our attention on the actual information being conveyed. Eventually, living in a world of continuous computing will be like wearing eyeglasses: the rims are always visible, but the wearer forgets she has them on—even though they're the only things making the world clear. ■

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**Always-on:** Blog reader Daniel Barkowitz writes, "This 'hands-on' participatory back channel even now pertains to the world of college admissions. At MIT, we are conducting our own social experiment with blogging about the college admissions and financial-aid process with our incoming MIT freshman class. The experiment has been a tremendous success, providing students a much more interactive way to get their questions answered and their issues addressed. As the director of financial aid at MIT, I walk around with my AIM channel always open on my cell phone and constantly am monitoring the blog for feedback. Not only does the technology exist to allow this, but the next generation of customers is expecting it."

**Plazes:** A Web service based in Cologne, Germany, that allows users to set up new "plazes"—representations of local networks complete with pictures, maps, comments, and lists of the people online—wherever they go.

**Being wired:** Blog reader Pete Sulick comments: "Are we taking the first steps toward digitizing our lives, or is this just an inevitably more efficient way to share information, like e-mail, TV, the telephone, radio, the pony express?"

# Your Genomic Diet

Your genetic profile could be the key to knowing what to eat—and staying healthy.

IMAGINE A DIET PLAN THAT SAW THROUGH TO THE CORE OF your being and beyond, that took into account not just the foibles and little secrets no one else knows about (it's awfully easy to dispose of incriminating Wendy's bags and 3 Musketeers wrappers) but even the secrets that *you* don't know—secrets that can help keep you alive longer and in better health.

This is the promise—and the threat—of the latest scheme for dramatic health improvement to fall out from the big bang of the Human Genome Project. Nutritional genomics—or nutritional genetics, or nutrigenomics—examines your diet and your genes to determine how they interact. Proponents argue that nutrients in food alter gene expression or structure, acting differently on different people according to their genetic makeup. Once these interactions are understood, the story goes, people can make up for inherited weaknesses or genetic flaws by eating differently and, when necessary, taking dietary supplements. Understanding the links between genes, specific nutrients, and a range of diseases—from diabetes and heart disease to less obvious diseases like some cancers and neurodegenerative syndromes—will result in a diet plan tailored to your very own gene profile.

By Corby Kummer

Photograph by Eric Tucker





If genes are destiny, science has been doing its best to alter that destiny, and of course venture capitalists, burned and jaded by high tech, are looking for ways to turn the science into profit. The new field of nutritional genomics is taking off in both the United States and Europe, with geneticists, nutritionists, and informatics specialists collaborating to analyze data from long-term health studies using powerful new genomic techniques. The deliberate pace of careful scientific research isn't fast enough, though, for baby boomers willing to spend whatever it takes to stave off if not vanquish the depredations of age. So companies are springing up, vying to take a swab from your cheek, test your DNA for a few genetic variants, and tell you that if you don't follow their guidelines you're headed for trouble. Given the state of current research, nutritional genomics hasn't progressed very far beyond standard, sensible dietary advice. But if you're paying a lot for the advice, it probably means you'll take it seriously.

I recently filled out a diet survey devised by one of the most ambitious of the new companies and got my score from the director of diet and nutrition. The biggest surprise was that what I eat is not more alarming. Perhaps because I write about food and am a restaurant critic, I eat a very peculiar and imbalanced diet (or perhaps I am simply peculiar and imbalanced, which is common in the food-writer game).

I skipped the company's genetic workup, which I didn't have time to take. Or so I said. The reality is that the number of diet-gene interactions that are sufficiently well understood to lead to specific and helpful advice is very small, and the number of relevant genetic variants for which it is practical or feasible to screen is even smaller; whereas a condition like obesity can involve hundreds of genes interacting in complex ways. In addition to these limitations, there are the uncertainty and risk of obtaining any genetic information about yourself. Companies, of course, promise complete confidentiality, but you never know. And the results of genetic screening are almost invariably ambiguous, with few straight paths from individual variant to effective intervention. I found it telling that the academic researchers I asked hadn't had themselves screened (or bothered to try the experiment I had in mind, of submitting the same swab with two or three completely different diet surveys).

My discussions with several researchers and one dietician did make me think that the field of nutritional genomics has real promise. And I might even start eating more fatty fish—though I fear that like many people told to eat fatty fish, I'm likelier to line the pockets of the dubious dietary-supplement industry. That industry, like all the big food processors, is looking hungrily at every development in nutritional genomics.

A leading research center in the new field is the Center of Excellence for Nutritional Genomics at the University of California, Davis. It owes its prominence to a five-year, multimillion-dollar grant from the National Institutes of Health, and to the efforts and vision of its director, Raymond L. Rodriguez, a cellular and molecular biologist. Rodriguez had been working to reengineer common food plants like rice, enriching them with important nutrients, and became increasingly curious about how human genetic variants enable or hinder metabolism of nutrients.

Like all geneticists, Rodriguez was excited by every step of the decade-long Human Genome Project, and like every shrewd

grant applicant, he tried to imagine the next big use for the information it yielded. Its first large and obvious commercial and scientific application was in pharmacogenomics—matching drugs to populations with certain genetic characteristics. Many researchers, Rodriguez among them, realized that they could apply a similar approach to nutrition, matching the effects of nutrients to genetic variants. Many drugs, Rodriguez says, are metabolites engineered to work on specific sites in the body to achieve specific goals. So is food, although food incorporates dozens or hundreds of metabolites, and they are usually very imprecisely engineered by nature. The action of specific nutrients on the body could be correlated with individual genetic profiles to similar useful effect—maybe even to similar profitable effect.

"You bring two things to the table," says Rodriguez, an affable man of medium height and luxuriant gray hair. "Your appetite and your genotype." He believes that the public, however buffeted by changing health messages, is ready to alter its diet according to gene type. There has been a "paradigm shift," he claims, in the public understanding of food, from the conception of it as a means of survival in a hostile environment, to the 20th-century demand for tasty and wholesome food, to the recent fear of food-borne microbes and a search for food free of them. Now people can intuitively grasp that food affects the way genes behave, for good and for ill. "When you consume a food, your genes are like a Christmas tree, red and green lights that flip on and off and flicker back and forth," says Rodriguez. "My Christmas lights differ from yours and flicker at a different rate. Over time, depending on your types of genes and how frequently they're turned on and off, you'll either be healthy or in a disease state."

In 2001, Rodriguez asked Wasył Malyj, a colleague at Davis with a background in molecular biology and informatics, if he would be interested in working on nutrition. Malyj began looking for tools but knew there was no such thing as a molecular video camera that can provide continuously refreshed data on how an entire genome responds to diet and environment. Malyj and his colleagues would have to content themselves with the expensive and partial snapshots provided by existing technologies. (One of these is the GeneChip from Santa Clara, CA-based Affymetrix, which can register the presence of particular biomolecules.) And Malyj recognized that algorithms developed at Stanford University in the 1990s could yield information about diet-gene interactions by helping to identify underlying patterns in hundreds of data sets involving thousands of different genes.

"Most investigators," Rodriguez says, "are under the false impression that one lab can do it all, or collaborate with a few others and computational scientists and crack the code. We wanted to network metabolic databases, genetic databases, and medical records." Malyj, a bearish man with great enthusiasm for his subject, adds, "We realized early that this would have to be multidisciplinary, and that not many people were doing it."

## Genetic Cookbook

The groundwork for nutritional genomics was laid by researchers like Jose Ordovas, now the director of the Nutrition and Genomics Laboratory at the Jean Mayer U.S. Department of Agriculture Human Nutrition Research Center on Aging at Tufts

University. Ordovas has spent decades studying the correlation between the metabolism of dietary fats and the risk of cardiovascular disease. Perhaps the best-studied diet-gene interaction involves low-density lipoprotein (LDL) cholesterol and high-density lipoprotein (HDL) cholesterol. One of the most interesting findings of recent years concerns HDL and LDL cholesterol and a gene variant, or allele, that regulates their metabolism. Some people who eat a diet high in saturated fat will never see an increase in their “bad” LDL cholesterol, whereas others will see a spike and won’t even benefit from following the universal advice to eat a low-fat diet. It turns out that the differing effects of a high-fat diet depend in part on an allele of a gene involved in the metabolism of “good” HDL cholesterol called the hepatic-lipase gene. Ordovas explains that the remedy for these frustrated dieters is to continue eating a normal amount of fat, but to make a very high percentage of it polyunsaturated.

This kind of targeted advice, which can be dispensed to anyone at the return of a genetic screening, is the great promise of nutritional genomics, and cholesterol is the teasing example that drives businesses and researchers forward. But it is only one needle in a very high haystack. Ordovas was able to identify the curious effect of the hepatic-lipase allele because he had access to data from the Framingham Offspring Study, part of the huge, very well funded, decades-long Framingham Heart Study conducted by NIH’s National Heart, Lung, and Blood Institute.

Walter Willett, a professor of epidemiology and nutrition at the Harvard School of Public Health, conducted a review of the Davis center in his capacity as chairman of its external advisory committee. He told the Davis researchers that new observational studies would be prohibitively expensive to mount, and that the center should devise questionnaires to be incorporated into established long-term health trials and seek to obtain serum or blood samples from subjects to screen for genotype. Already the center has begun several collaborations, one with a long-term asthma trial under way at the University of California, San Francisco, where the researchers will look for connections between diet, genotype, and the disease, and others with studies of prostate cancer and restricted-calorie diets.

The study of diet-gene interactions in heart disease progressed so quickly, not only because that’s where the money was, but because the biomarkers for heart disease, like HDL and LDL cholesterol, are well understood and easy to measure. But the Davis researchers are hoping that the accumulation of genetic information about many populations, combined with the techniques of systems biology and the algorithms Malyj and his colleagues are using, will be able to disclose more-obscure diet-gene interactions.

They have their work cut out for them. Cancer, despite a huge scientific literature and investment in research, illustrates the difficult proposition for nutritional genomics. Markers vary for each kind of cancer, and environmental stimuli might play important roles in the disease’s progress. For cancer, and for cardiovascular and other diseases, the field’s first results are likely to be generalized recommendations for large ethnic groups whose genotypes

are relatively well defined and easily studied, and of course for men and women, whose needs for and reactions to nutrients can differ greatly. Despite the number of genetic-screening companies contending to charge hundreds of dollars to devise individual “DNA diets,” the narrowest focus Rodriguez foresees in his lifetime, he says, is at the level of “a middle-aged man of Hispanic descent” like himself. And that, he says, is “close enough.”

### Soy Solutions

It is these subpopulations that NIH expects Davis to study. The Davis center’s grant comes from NIH’s National Center for Minority Health and Health Disparities. Already researchers have found that African-American and Mexican women exhibit differences in folate metabolism, which can affect cancer risk and has been implicated in neural-tube defects in newborns. Green leafy vegetables are rich in folates. But if a diet recommendation is to be realistic or helpful, it must take into account what people can afford and whether they can find it. And that’s to say nothing of whether they like eating, say, broccoli (the cure-all, along with its cruciferous cousins cauliflower and cabbage) and soy, which many non-Asians view with dread.

Rodriguez is excited about preliminary results involving soy and prostate cancer, to which African-American men are disproportionately susceptible. In 1997, a researcher at the University of California, Berkeley, Alfredo Galvez, studied the benefits of lunasin, a bioactive isoflavone in soy apparently associated with reduced levels of heart disease and several cancers, including

prostate. Lunasin seems to increase the expression of genes that monitor DNA damage and suppress tumor cell proliferation.

These results—like so many that the public and the food industry seize on—are based on cell cultures, not human studies. So Kevin Dawson, senior informatics scientist at the Davis center, initiated a collaboration with the Prostate Cancer Education Council in Colorado, where rates of prostate cancer are high and where data collection is both broad and detailed. The results seem so promising that they

should encourage everyone to eat soy protein once a day (unappetizing as that might sound). But Dawson cautions that the picture of prostate cancer he is trying to draw involves many more nutrients, and that the effects of soy in different populations—especially in populations that have not traditionally included soy in their diets—must be studied over the long term.

For now, even Rodriguez is disposed to generalize his diet recommendations. For example, he recently told a man who has sought alternative treatments for his late-stage prostate cancer to eat tomatoes and sauces with tomato paste for their lycopene, which is strongly associated with lowered incidence of prostate cancer, and to try to eat soy, too, in soy milk or edamame.

**Optimists say that in ten years the number of genes that can be reliably and cheaply tested for will be closer to 1,000 than 20, and that patients will arrive at health providers’ offices carrying gene chips.**

Anxious yuppies want more sooner, of course, not to mention eternal, aging-free life. Companies offering “DNA diets” promise customized, expensive diets that fit right in with the current idea of personal service as status symbol. It hardly matters, perhaps, that the number of genes such companies are able to test for is minuscule, and that the advice they can give will almost certainly not be a matter of life and death. Their selection of genes is based on published papers, their nutritional guidance usually the latest from the American Heart Association. What matters is that the idea is catching on, in a very small and very health-conscious segment of the population—and that the commonsense advice the companies are likely to give, with the smallest soupçon of genetic-based rationale, is unlikely to do any harm.

Rodriguez does see home testing in the future: “The trend is faster better cheaper, for private, in-home, disposable tests. Pee on a stick and see if I’m at risk for many diseases.” And optimists say that in ten years the number of genes that can be reliably and cheaply tested for will be closer to 1,000 than 20, and that patients will arrive at health providers’ offices carrying their own gene chips, which can be fed into computers.

If the American Dietetic Association has its way, those health providers will be dietitians. Last April, the journal of the 65,000-member group published a review of nutritional genomics that concluded that the “limited number of certified genetic counselors” left the field clear for “dietetics professionals...to play a primary role.” Dietitians as counselors is fine by Rodriguez, who says that doctors want the kind of yes/no, disease/not disease binary conclusions that nutritional genomics can’t yet provide, and that dietitians know something about preparing food, whereas nutritionists concentrate on research. That dietitians know much about preparing food is a debatable point, at least for food writers, but they often do take a concerned interest in your welfare.

## Diet Advice

I filled out a diet survey from Sciona, a company whose website promises “professional genetic screening” that allows people to base “their most important health decisions” “not on fashion but on their own personal ‘inside’ story.” For several hundred dollars, a customer receives a report based on a detailed nutritional questionnaire and the results of a cheek swab that tests for 19 genes. I knew that I didn’t have the time for a genetic screening, but I did look forward to shocking a dietitian.

Yael Joffe, however, the dietitian in charge of designing Sciona’s questionnaires and

correlating the results with the swab report, was far too sensible and nice to be shocked. She calmly assessed my diet, which is usually low in meats except when I taste through an entire menu, as I do a few times a month as a restaurant critic, and exceedingly high in sugar, owing to an insatiable sweet tooth.

Sciona tests only 19 genes whose variation can result in specific dietary recommendations, Joffe assured me, so its report is not a general assessment of a customer’s health. Its main areas of concern are heart health, bone health, inflammation, detoxification, and oxidative stress. She took me through each area, explaining the advice she would give me based on my answers and how it might change if I had a specific genetic variant. Unsurprisingly, the advice accorded strongly with common sense. And as someone who holds buying from farmer’s markets to be a God-given mandate, I was heartened to hear her say in every area that the first recommendation would be to increase (or decrease) consumption of a certain real food and only in the event of certain genetic variants to take supplements.

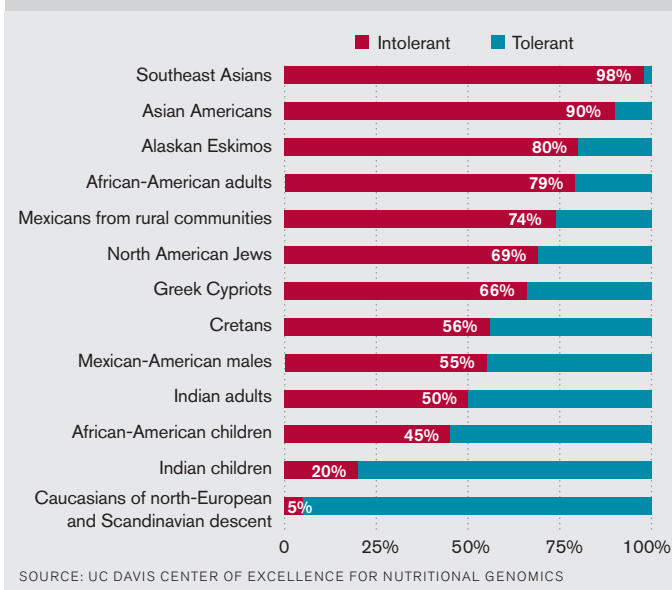
Such advice, of course, is far from a personalized diet based on nutritional genomics. In the same way that personalized medicine has been slow to emerge from pharmacogenomics, it’s likely to be a while before our genetic profiles will tell us exactly what to eat. For starters, nutritional geneticists will need far cheaper and faster genetic-screening tools.

Still, the makers of omega-3 and folic-acid supplements, and of calcium supplements for women, will be very pleased if messages like Sciona’s filter down to the public. My own biggest shock: that because I don’t drink soda, my extreme consumption of sugar doesn’t throw my entire diet out of whack. I’m a bit light on whole grains and the dread omega-3s—which, however, I was pleased to learn can be obtained not only through mackerel and sardines but also through the delightful-sounding flaxseed hot cereal. I’m ready to make Pascal’s wager, as Ray Rodriguez calls the proposition of following dietary advice. (Blaise Pascal, the 17th-century French scientist and philosopher, argued that if erroneously disbelieving in God consigns you to hell, but erroneously believing in God has no consequences, it’s only rational to believe in God.) If flaxseed on the stove in the morning and sardines from the can at lunch are what will help me live healthier and longer, I’ll learn to like them. But I won’t give up sweets. ■

*Corby Kummer is a senior editor at the Atlantic and the author of such books as The Joy of Coffee and The Pleasures of Slow Food.*

## Milk Mutation

One example of a genome-diet interaction that varies across populations involves adults’ ability to digest fresh milk. A single mutation in the genomes of northern Europeans enabled them to tolerate lactose.





# Congratulations

## The Lemelson-MIT Awards for Invention and Innovation

2005



LEMELSON-MIT PROGRAM

### Elwood Norris

\$500,000 Lemelson-MIT  
Prize Recipient

Independent inventor Elwood “Woody” Norris’ fascination and prior work with sound led him to create HyperSonic Sound (HSS®), a device that mixes sound frequencies to create crisp, clean sound that can be directed like a laser beam. Norris also developed AirScooter®, an ultra-light, easy to operate personal flying craft designed for recreational use. He holds 47 patents, with more pending, for an array of inventions, including a transcutaneous Doppler system and an ear-mounted speaker/microphone device.

courtesy of Elwood Norris

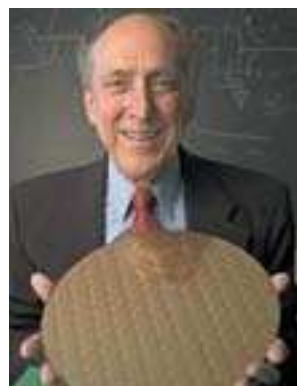


### Robert Dennard

\$100,000 Lemelson-MIT  
Lifetime Achievement  
Award Recipient

Robert Dennard helped change the face of computer technology with dynamic random access memory (DRAM) in 1967. Created at IBM, DRAM’s denser memory cell storage on a single chip has enabled smaller, portable computers and is still the paragon in the industry today. Dennard and colleagues also conceived the scaling theory, published in the 1974 paper—“Design of Ion-Implanted MOSFETs with Very Small Physical Dimensions.” Since its inception, it has been deemed the principal guide for designing submicron dimensional devices.

Photo by Alan Orling, courtesy IBM



#### Call for Nominations

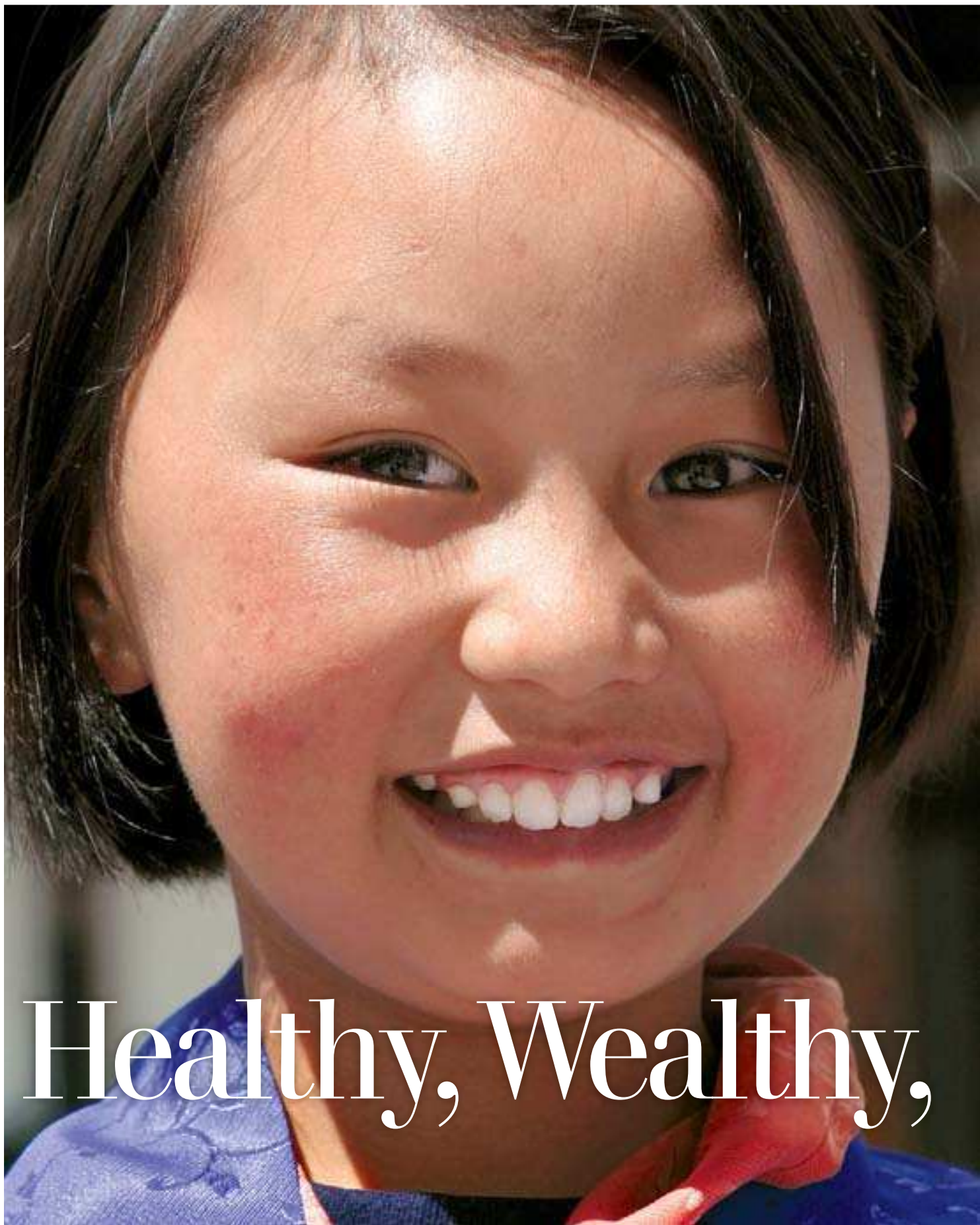
The deadline for nominations for the 2006 awards is October 7, 2005.

For further details or a nomination packet, visit <http://mit.edu/invent/a-main.html>, or contact 617.253.3352.

For more information on the Lemelson-MIT Program and its award winners, visit:

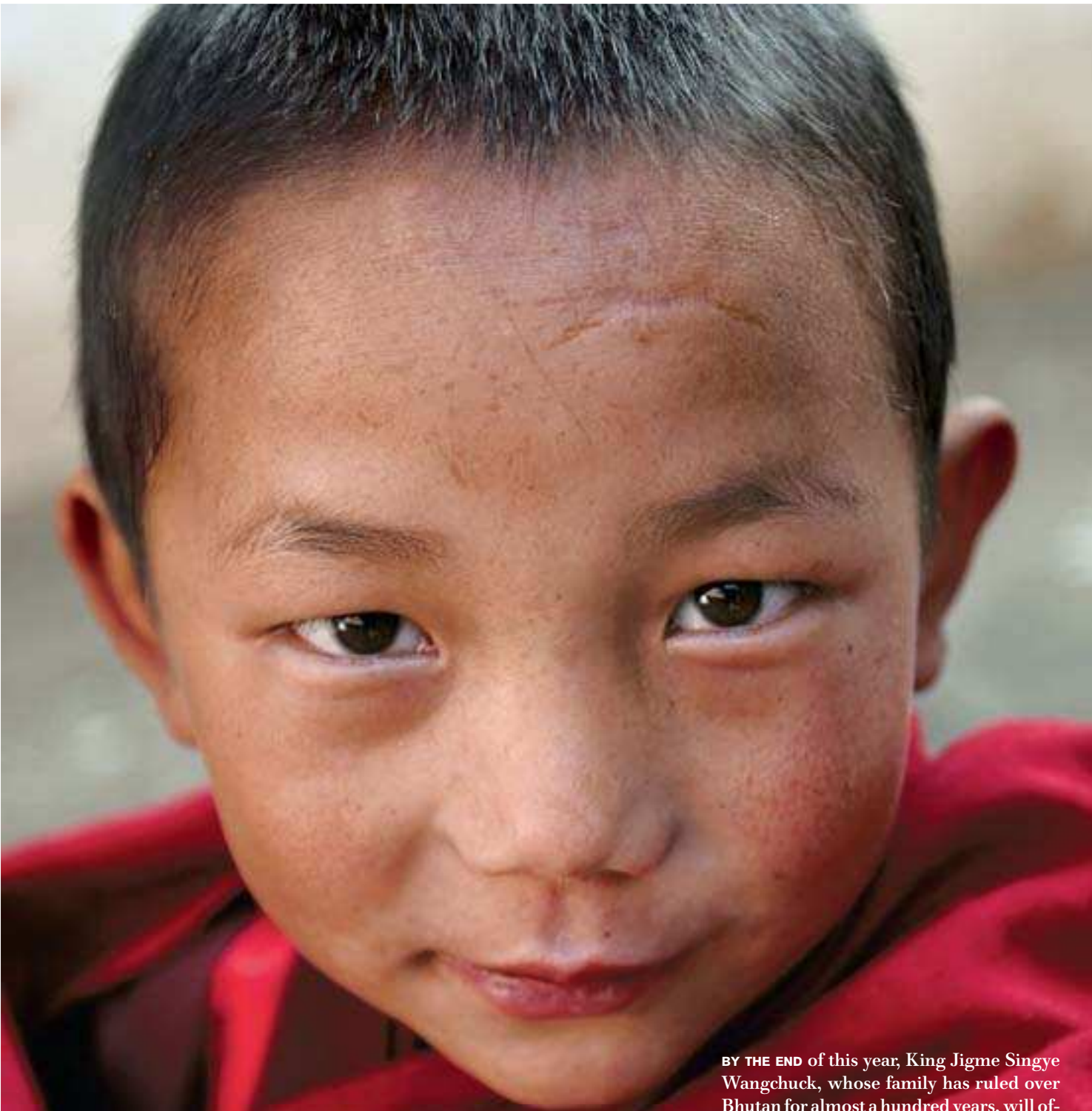
<http://mit.edu/invent>





# Healthy, Wealthy,





# and Wise?

The Himalayan kingdom of Bhutan wants to show that modernization can be enlightened.

By Stephen Herrera Photography by Friendly Planet

BY THE END of this year, King Jigme Singye Wangchuck, whose family has ruled over Bhutan for almost a hundred years, will officially hand over power to the people. Nobody wants to see him go, but the king himself has decided that he must take a less active role in government. By his own account, he does not want to see the throne stand in the way of the remarkable modernization under way in Bhutan.

Under the current king's rule, this tiny Himalayan kingdom (whose population is still unknown, but which is estimated to





range from 700,000 to about two million people) has become a rare innovator among developing nations. Rejecting the models of urbanization and unregulated market development usually promoted by the U.S. government, the king has crafted the framework for a political economy based on a theoretically harmonious mix of representative government, south-Asian-style capitalism, traditional religious values, environmentalism, hydropower, tourism, mandated preventative medicine, and universal health care.

Now comes the real test: can Bhutan and the king's enlightened framework withstand the messy business of democracy and development, and the problems that tend to follow? "With China, India, and Nepal sitting on its borders," says Stephen Cohen, a senior fellow at the Washington, DC, policy think tank the Brookings Institution who specializes in south-Asia security matters, "and donor nations in the West constantly pushing new models upon the developing nations they fund, anything can happen."

But if Bhutan can prove that democracy, social equality, sustainable development, environmental protection, and limited technology are compatible with Buddhism and 21st-century modernization, it will be an interesting example for other poor nations who want modern technology and economies—but who want them on their own terms.

Or as the king explained at a conference in his country last year, "There must be some convergence among nations on the idea of what the end objective of development and progress should be."

## The Happy Factor

If Bhutan's experiment succeeds or fails, many will credit or blame the country's very Buddhist (or very eccentric, depending on whom you ask) notion of "gross national happiness." In the late 1980s, Bhutan's University of Oxford-educated king famously asserted that gross national happiness (GNH) was more important than gross national product (GNP). Among the core principles of GNH, he said, are good governance and sustainable economic development, cultural and religious preservation, eradication of poverty, and environmental protection. More recently, health care and education have been added to the concept.

Even those who like the idea of GNH would admit that it is half-baked. The Centre for Bhutan Studies, the agency in the capital city of Thimphu responsible for the promotion of GNH nationwide, concedes that GNH can't be measured yet—but promises it will be someday. The center is already trying to create a baseline. In

May, Bhutan's first nationwide census set about trying to find out whether people are happier than they were 10 years ago. Conclusions will be published next year.

It's easy to find GNH quaint. Nevertheless, when I was in Bhutan earlier this year, everyone I spoke to—from intellectuals to entrepreneurs to young students in the countryside—said GNH was a good way of keeping government honest.

In his modest office in Thimphu, over a cup of ginger tea with milk, Prime Minister Lyonpo Yeshey Zimba told me, "Bhutan's most valuable assets are its culture, religion, language, environment, and people. In a sense, we're like any small company with a niche. We must modernize to survive. But we must do it in a way that ensures that we are not destroying, in the process, what makes us unique. GNH was the king's effort to make sure that we don't lose ourselves in modernization."

## Deep Impact?

What about more-conventional measurements? There's plenty to measure in Bhutan: some of it good, some of it less so.

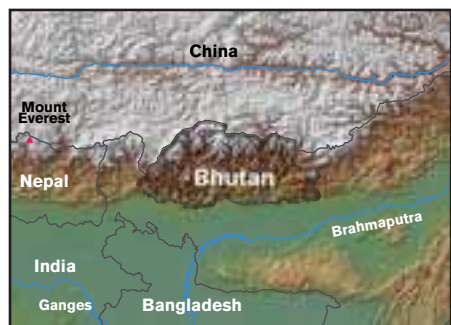
First, the bad. By some estimates, as much as 90 percent of the population lives at subsistence level. The country has a \$598 million debt. Nearly two-thirds of Bhutan is still without electricity, while a quarter are without clean drinking water.

This last fact may be one reason why Bhutan is not a very healthy place to live. The average life expectancy is 63 years—much lower than is common in richer countries. There are only a handful of ambulances. Those lucky enough to make it to a hospital in one of the larger towns, like Thimphu or Phuentsholing, will find large, modern-looking facilities. Trouble is, most of the staff aren't trained in basics like surgery or outpatient care. Diagnostics and acute and chronic care are virtually nonexistent.

But then, Bhutan only began modernizing in the 1950s. Previously, there were no paved roads, most homes were built from mud and grass, literacy was low, and the death rate was high. That Bhutan has progressed so far is thus remarkable. The current king, who came to the throne in 1974, invested the country's meager finances in an airport, an east-west road, bridges, national education, health care, and select energy-producing technologies like hydropower, which provides almost all the country's electricity. And it has worked, after a fashion.

According to the Asian Development Bank, Bhutan's GNP in 1985 barely topped \$45 million. By 2002, it was more than \$590 million. From 1999 to 2003, Bhutan's average GDP grew by 6.72 percent every year. Save for China, none of Bhutan's regional neighbors—including India—saw more GDP growth during the same period.

If Bhutan is still not a very healthy place to live, it's certainly better than it was. The number of health facilities in the country rose from 65 in 1985 to more than 200 today. Infant mortality rates in 2000 were half of what they were in 1985, while average life expectancy rose from 48 years to 63 during the same period.





The country has seen a remarkable growth in general education. The literacy rate is almost 50 percent, whereas in the early 1990s it ranked the lowest among the least-developed countries. More than 90 percent of Bhutanese children now reach at least the fifth grade. The country's first university opened its doors in 2003.

Technology use has increased, too: according to World Bank figures, from 1999 to 2003 the number of fixed-line and mobile-phone subscribers jumped from 18 to 45 per 1,000 people; personal-computer ownership nearly tripled from 5 to 14 per 1,000 people. In 1999, the country introduced its first commercial Internet service provider, DrukNet, and its first television broadcasts, through the Bhutan Broadcasting Service (BBS). For roughly \$60 a year, a Bhutanese home can have both. This is, of course, a lot of money in Bhutan. According to DrukNet, neither it nor the BBS has a large subscriber base, as yet, because two-thirds of the households in Bhutan don't have electricity. But DrukNet claims there are already a combined 120,000 subscribers.

Bhutan has gone from being off-limits to tourists to being the most coveted destination for well-heeled adventurers—in part because travel visas are rationed, giving travelers the sense they are seeing something very special. They are, especially if they are fortunate enough to stay at the five-star Como Uma Paro or the Amankora, or the soon-to-open Yangphel Hotel.

But even as it modernizes, Bhutan has also strengthened or enacted laws designed to control pollution, mining, and logging. Almost 70 percent of the country's forests are protected. New laws ban smoking, gambling, and prostitution; anticorruption and construction codes have also been enacted.

### The Challenge Ahead

In its efforts to promote its citizens' happiness, the Bhutan government remains preoccupied with health care. Health care in Bhutan is free; but health-care costs are rising, says Gado Tshering, director of Bhutan's health department. Tshering wants to invest in a magnetic-resonance imaging station that would let doctors diagnose disease earlier and with greater confidence.

"Capturing disease faster would save us a lot of money," he says. When a patient's illness exceeds Bhutan's medical capabilities—which happens often, since most of the country's health-care facilities are focused on treating pain, broken limbs, and gastrointestinal-tract illnesses—the government pays to have the patient sent to Calcutta or Bangkok. This is expensive and unsustainable.

"Eventually, probably sooner than later, we will need a lot more money, because the nature of disease in Bhutan is changing," Tshering says. "We're seeing more obesity, pain, depression, and hypertension." These are expensive diseases to treat, especially when not caught until late stages. Left unchecked, health-care expenses will impinge on development plans.

George Martin suspects that Bhutan's king and his GNH framework will be studied for years to come. Recently retired from a career at the National Institutes of Health, Martin traveled to Bhutan last year as part of a delegation to assess the country's progress in public health. "Health care is still a struggle because of things like geography, finances, training, and sanitation," he told me recently. "But they get that the name of the game is preventative medicine."

**"The whole kingdom has made a sustained effort to hold on to what is precious in its past while trying to bring its people into the future."**

### Shangri-la

Can a poor nation like Bhutan achieve limited modernization, adopting only the media, the particular technologies, and the developmental policies that fit into its odd concept of GNH? Will Bhutan keep its forests off-limits to loggers?

Will it continue to put a cap on the number of tourists who visit the country? Can it afford to invest more than a third of its budget in health and education?

So long as Bhutan declines foreign investment that goes against its environmental policies or infringes upon its sovereignty, it *can* do all of these things. Whether it should is something the Bhutanese themselves must decide.

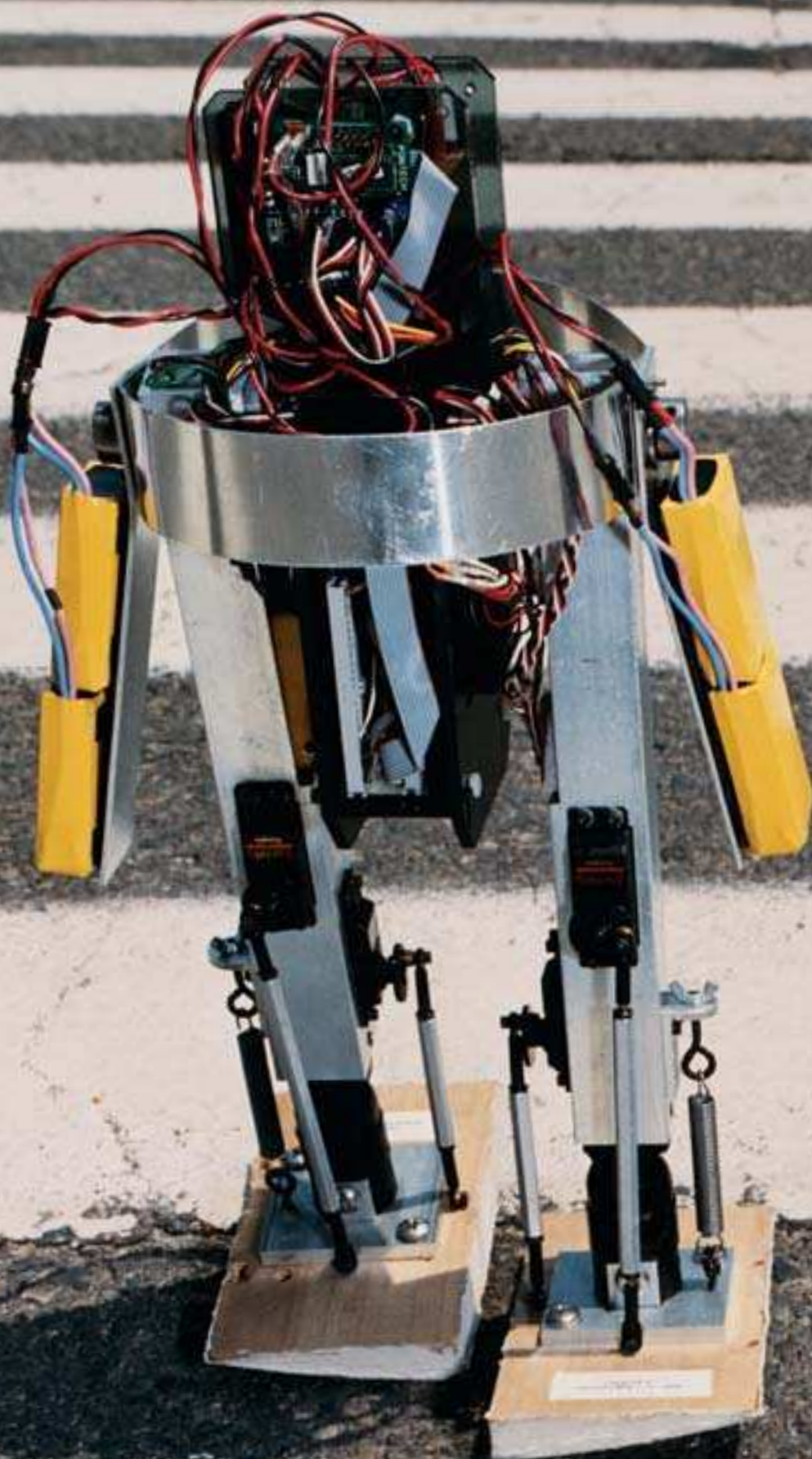
One can easily imagine an economic liberal arguing that once they are no longer ruled by the king's whims, the Bhutanese may prefer a more conventional kind of development to their picturesque poverty. The Bhutanese might want more affluence and economic choice for themselves and their families. The economic liberal would insist that it is *Westerners* who are most bewitched by the idea of Bhutan as an untouched paradise.

The country tends to evoke strong sentiments in visitors. It bewitched me. And I am not alone. Long-time *Time* essayist and travel writer Pico Iyer has seen more of the world than most. He calls Bhutan the last Shangri-la. In a picture book about Bhutan commissioned by the Amankora hotel, Iyer writes, "We aspire, many of us, to step out of the accelerated rush of our wired planet, and into somewhere pristine; and we find more and more, that it's nearly impossible....In Bhutan...the King has outlined a notion of gross national happiness to stand for a different kind of wealth and shelter."

Maybe the Bhutanese think that Shangri-la is worth preserving. During my visit to Bhutan, I felt that most Bhutanese share the king's aspirations. Iyer saw what I did: "The whole kingdom has made a sustained and conscious effort to hold on to what is precious in its past while trying to bring its people into the comfort and safety of the future." ■

*Stephan Herrera is a contributing editor to Technology Review.*









# Machine in Motion

They don't make robots like they used to. Instead of plodding through a limited repertory of programmed moves, **Toddler** learns to walk with a loose, easy gait. Built by Russ Tedrake of MIT's Computer Science and Artificial Intelligence Laboratory, the robot combines ideas from biomechanics, control theory, and machine learning to push the limits of today's robotic technology.

By Gregory T. Huang **Photographs by Chris Mueller**



Tedrake's team, which included then undergraduate Teresa Zhang, designed Toddler in the lab of MIT computational neuroscientist H. Sebastian Seung. The robot's control system, says Tedrake, uses "the natural dynamics of the body."

#### ARM

Lithium-polymer battery packs provide power and counterbalance the opposing leg as it swings forward.

#### HEAD

Wireless Ethernet allows a remote operator to start and stop Toddler.

#### COMPUTER

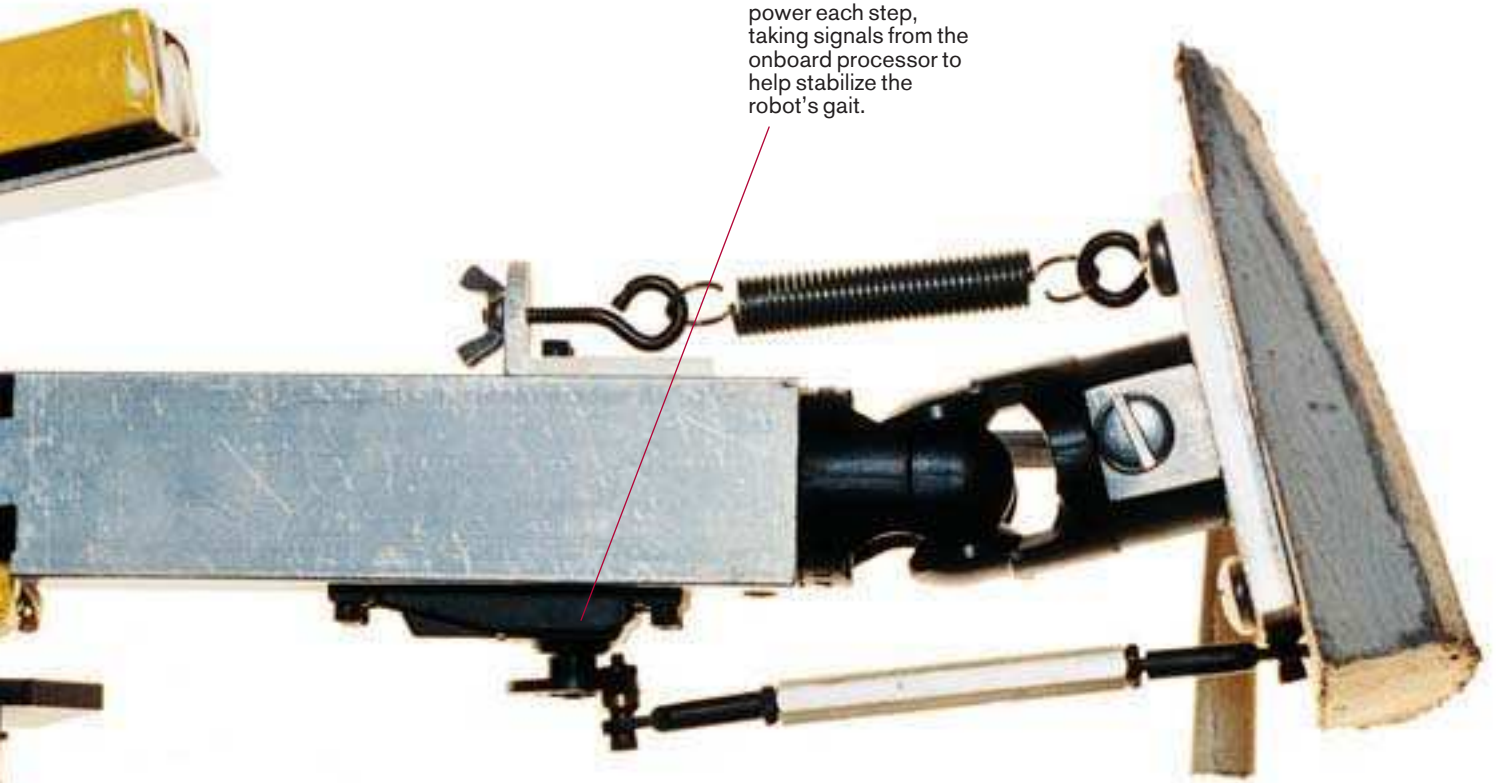
An onboard Pentium chip learns to control Toddler's gait on the fly, using sensor information about the body's orientation to adjust control signals to the ankles.

#### HIPS

Passive hinge joints allow the legs to swing freely without power.

#### ANKLE

Electric motors power each step, taking signals from the onboard processor to help stabilize the robot's gait.

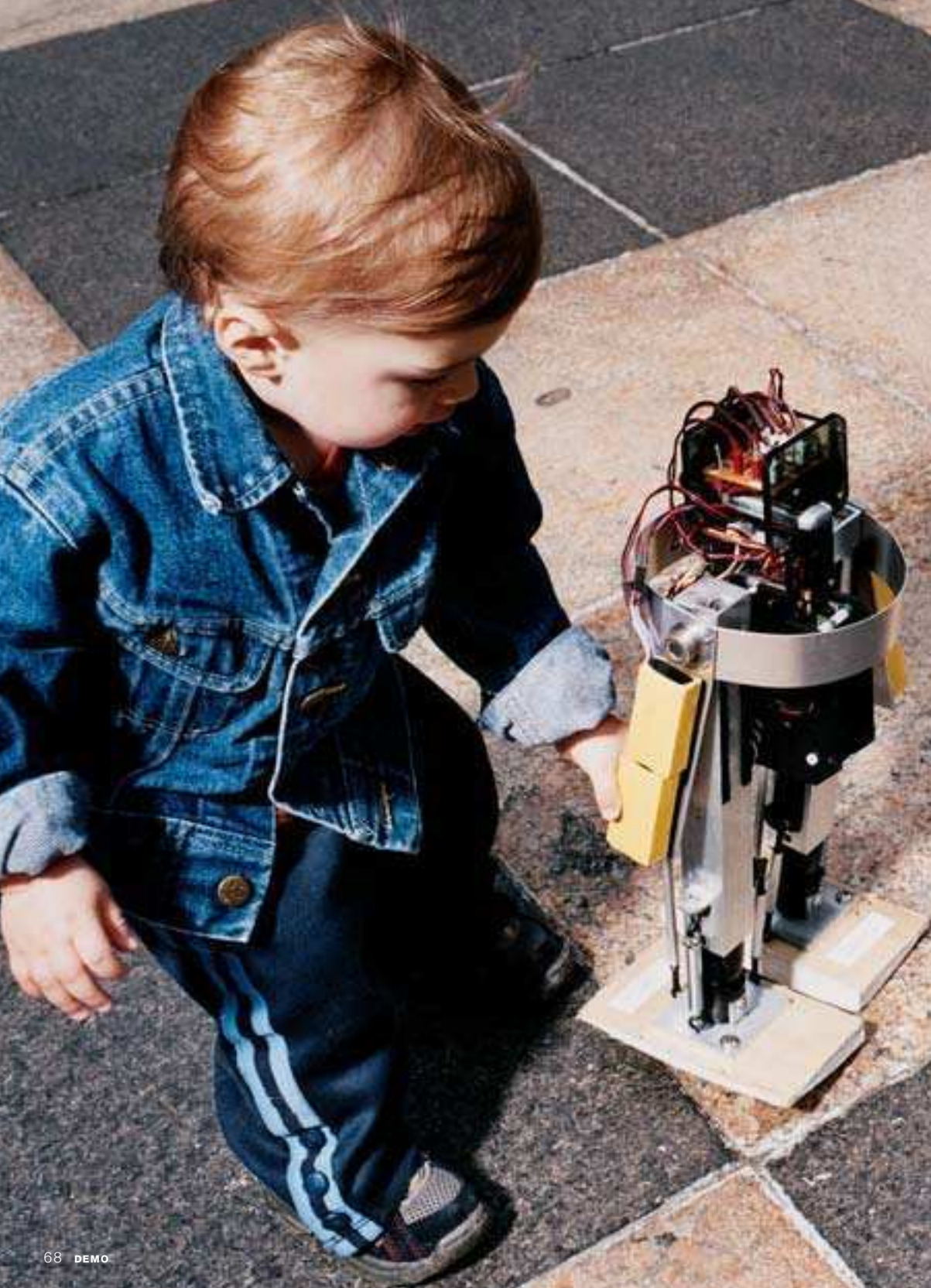


#### FOOT

Wooden feet are coated with latex paint for traction. Tapered soles allow Toddler to rock from side to side as it moves forward, allowing better foot clearance.



Tedrake hopes that designing Toddler to learn to walk will provide insights into human learning, rehabilitation, and prosthetics. His approach could also help make robotic companions and helpers better able to function in human environments.







Toddler learns to walk in minutes without any prior instruction. **Top:** The robot's mechanical design lets it walk down a ramp with its computer turned off. **Bottom:** With this "passive" walking as the target behavior, ankle motors keep Toddler moving on level ground, and the onboard processor adjusts the gait from step to step to keep it stable. The next-generation robot has knees and will navigate tougher terrain.

## Reviews

Our reviews use any artifact—a book, a product, a government report, a movie, a research paper—as the occasion for a contemplative essay on some technological controversy.

76 Bill Joy on the Birth of the PC

80 The “Father of Ecstasy” on Psychedelic Drugs

# Summer Stuff

As vacation rolls around, *TR* empties its beach bag of timely gadgets, gizmos, and other entertainments.

Illustrations by Peter Stemmler

## Podcasting Made Painless

### PERSONAL BROADCASTING//

It wasn't so long ago that publishing a Web log (blog) required some Web programming skills. Then along came Blogger, software that made blogging easy enough for the masses. Blogger became so popular that Google bought it in 2003. Substitute “podcast” for “blog” in the preceding sentences, and you'll understand the vision behind the new Web-based podcasting tools developed by **Odeo**, a San Francisco

startup launched by Blogger cocreator Evan Williams and his former neighbor, Noah Glass.

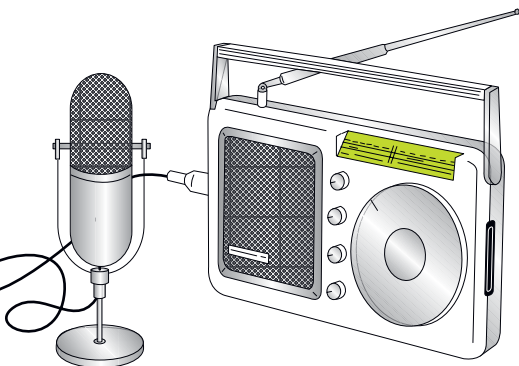
Podcasting, for the uninitiated, is the hot independent-media trend of 2005; amateur broadcasters record their own news shows, commentary, or interviews on whatever subjects they choose and put the audio files on the Web. Anyone with an Apple iPod or other digital music player can subscribe to the shows and download and listen to them. Unfortunately, being a podcaster has, until lately, also meant being an expert in digital recording and mixing.

In May, I visited Williams's office around the corner from San Francisco's South Park to try out Odeo's service. Just as Blogger did for blogging, Odeo turns the process of making a podcast (a basic one, anyway) into something any semi-competent PC user can handle. It also takes all the pain out of finding and downloading podcasts (Apple has promised that the next release of iTunes, its music organizer, will do this, too; but it won't produce podcasts). And it will be at least partly free. The audiences of millions that podcasters have been craving may arrive soon.

The neatest part of the program is Odeo Studio, which runs inside a Web browser and

converts a PC into a rudimentary recording studio. I used it to produce my own podcast, which you can find on my blog, [wade.trblogs.com](http://wade.trblogs.com), at [www.technologyreview.com](http://www.technologyreview.com), and at [Odeo.com](http://Odeo.com). Making a podcast was as simple as clicking “Record,” talking into the PC's built-in microphone (you can also use an external headset), then clicking “Stop.” Clicking “Publish” placed the podcast in my own “channel,” to which others can subscribe. What was a tedious process is now quick and mildly fun.

Odeo will no doubt cement Williams's reputation as one of the founding fathers of the personal-publishing revolution. And it may not be long before Google comes knocking again in South Park. **Wade Roush**







## Hacking the PlayStation Portable

### GAMING//

Hoping to topple Nintendo from its decade-long leadership in the handheld gaming market, Sony this spring released the **PlayStation Portable (PSP)**. Ironically, it may give Nintendo stiff competition, not because of its wide-ranging built-in applications, but because of its many security flaws. Hackers have exploited these

loopholes to install a variety of unauthorized applications on their PSPs, from Web browsers to TiVo viewers, making the device more versatile than Nintendo's game-oriented DS.

Out of the box, the PSP is already more than a game player. It has MP3, movie playback, and photo-viewing capabilities. But even these features aren't enough for a subculture of frenzied gadgeteers.

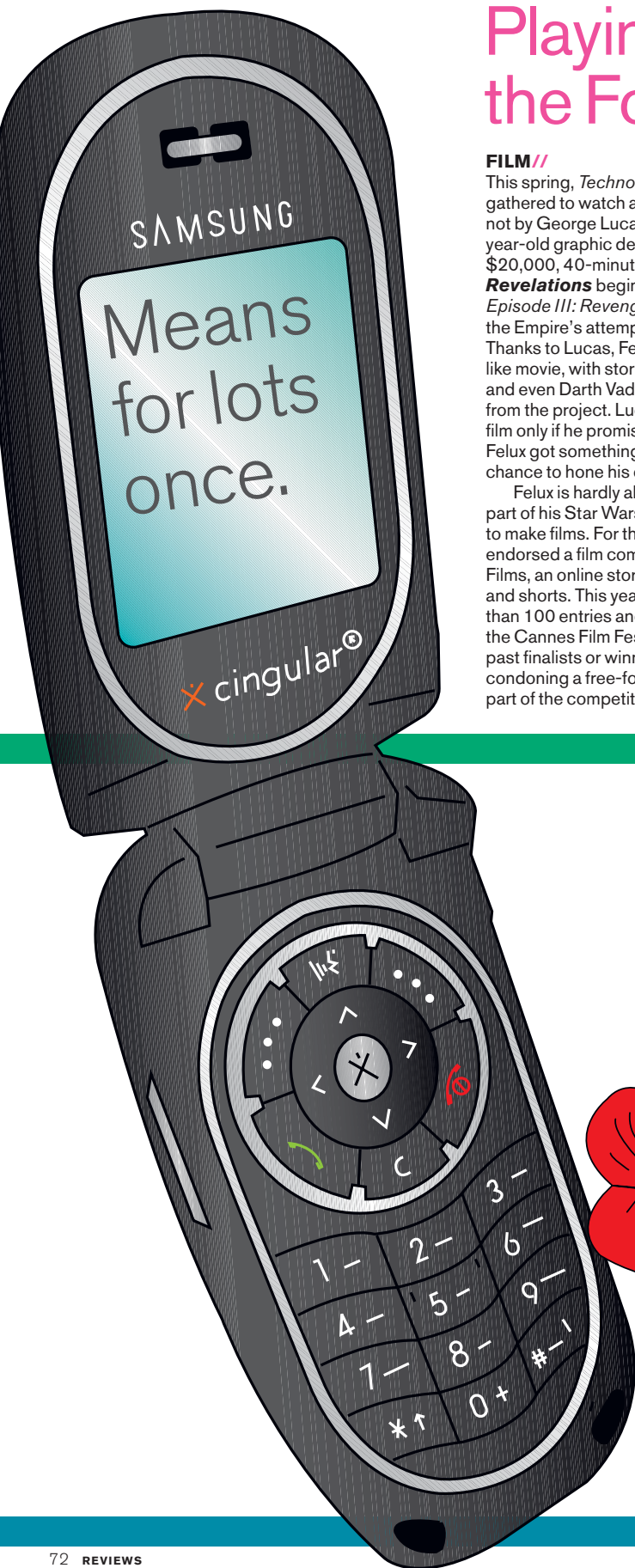
Hackers have widely distributed detailed online instructions that show how to crack the PSP's encryption by punching in codes using the PSP's buttons. The instructions are easy to follow and complete with how-to visuals. Using the PSP's wireless connection, users can then download software for RSS feed reading, PSPcasting, and many other applications. To close these loopholes,

Sony has developed security patches that are included in its new game software and install themselves automatically when a user loads a game. But this is only encouraging hackers to find new holes.

The PSP's security weaknesses may have contributed to its phenomenal success. It sold 500,000 units within the first two days of its March release and twice that in its first six weeks.

Nintendo's new Game Boy Micro and improved DS come out later this year, but their sales may suffer, since they don't offer the multimedia options and innate hackability of the PSP, making them attractive only to gamers. After dominating living rooms for more than a decade, Sony is poised to take over backpacks as well as briefcases. The PSP is available for \$249.

**Aleks Krotoski**



## Playing with the Force

### FILM//

This spring, *Technology Review* staffers gathered to watch a new Star Wars film, directed not by George Lucas but by Shane Felux, a 33-year-old graphic designer and Star Wars fan. The \$20,000, 40-minute saga **Star Wars: Revelations** begins after the end of *Star Wars Episode III: Revenge of the Sith* and chronicles the Empire's attempt to eradicate the Jedi.

Thanks to Lucas, Felux made a very Star Wars-like movie, with storm troopers, light-saber fights, and even Darth Vader. Yet Felux never saw a dime from the project. Lucas allowed him to make his film only if he promised to show it for free. Still, Felux got something out of the experience: a chance to hone his craft and get recognition for it.

Felux is hardly alone. Lucas has opened up part of his Star Wars universe for fans who want to make films. For the last four years, Lucas has endorsed a film competition hosted by Atom-Films, an online storehouse of movies, trailers, and shorts. This year's competition drew more than 100 entries and has gotten so popular that the Cannes Film Festival recently screened 12 past finalists or winners. But Lucas is not condoning a free-for-all. All filmmakers, whether part of the competition or not, must follow at least



two rules: don't make any money from the project, and don't harm the franchise (which can be a difficult rule to adhere to, since it's not clear what Lucas thinks will harm the franchise).

While Lucas has ultimate control over his Star Wars intellectual property, he is giving up-and-coming directors the ability to test their chops in front of a large audience. (There were more than one million downloads of *Revelations* in the first week of its release.) And if more film properties are offered up for creative reuse, it's likely that this network of filmmakers will grow until it is vibrant and sophisticated enough to produce not just more fan films, but originals like *Clerks*, which helped launch the career of the now well-known director Kevin Smith. **Brad King**

## Thumbless Text Messaging

### DICTA-CELL PHONE//

Billed as the first speech-to-text mobile phone in the United States, the **Samsung P207**, released earlier this year, allows users to dictate text

messages instead of keying them in. Unfortunately, this little clamshell has a tough time translating even the simplest phrases correctly.

I spent three minutes training the software, developed by Woburn, MA-based startup VoiceSignal, to recognize my voice by saying 122 words into the phone. To compose a text message, I had to speak slowly, with distinct pauses between words. When I tried to dictate the sentence "Meet me for lunch," the phone interpreted it as "Means for lots once."

I gave the phone a second chance, repeating the voice recognition training in a quieter room. This

time, it only got one word wrong, replacing "meet" with "let." Still, the slow pace of dictation and the high number of errors made the feature cumbersome. The phone was, however, terrific at recognizing phone numbers and names, making autodialing more convenient. Like speech-to-text software for PCs, which still hasn't lived up to the promise it showed in the 1990s, software for cell phones will need a few more generations before enough of the kinks are worked out to make it truly useful. The Samsung phone is available through Cingular for \$99.99 with a two-year contract.

**Anita Chabria**



Meet me  
for lunch.

## ONLINE TICKET SCALPING//

I always thought the Internet might curtail conventional ticket-scalping—the for-profit reselling that is restricted or prohibited in 27 states. Efficient online sales would widen the retail bottlenecks that arguably worked to the scalpers' advantage. Then, honest resellers would meet buyers online. This may be happening, but if a recent experience with StubHub.com, a ticket resale site, is any guide, the Internet is also making scalping efficient and anonymous.

A friend of mine—we'll call him "Jim"—who lives in Boston used **StubHub** to clear a \$169.40 profit on a pair of extra tickets to a Green Day concert. First, he went online to Ticketmaster and bought eight \$36 tickets to the Grammy-winning band's April 30 show in Amherst, MA, paying \$68 in service charges. Then he registered on StubHub for free and priced one pair at \$310. A few days later, a fan from a Boston suburb bought them for \$304. (Jim had agreed to let StubHub lower the price over time.) After the buyer paid for the tickets, StubHub e-mailed Jim a FedEx shipping label with the buyer's address and StubHub's San Francisco address as the return address. Using this label, Jim sent the tickets anonymously to the buyer. When the buyer told StubHub he'd received his tickets, StubHub pocketed 15 percent (\$45.60) of the sales price and released the rest to Jim via PayPal, the online payment service. According to its website, StubHub collects an additional 10 percent of the sales price and the shipping fees from the buyer.

The buyer had technical difficulty with the website, and the sale was completed over the phone with a StubHub agent. But no one asked Jim if he had the ticket broker's license required by the state of Massachusetts or noticed that his price far exceeded the state-mandated cap of \$2 above face value, plus a reasonable broker's service charge. When told of Jim's transaction, StubHub's CEO Jeff Fluhr said, "We have a very clear and very strict user agreement that clearly states that you need to obey state and federal laws." (Jim says that he did not read the user agreement.) StubHub uses a California return address for administrative reasons and hides sellers' identities to prevent loss of business to side transactions, Fluhr said.

New research suggests that online ticket reselling is common. Dan Elfenbein, a University of California, Berkeley, economist, has looked at online football ticket scalping and found that 1.6 percent of all NFL tickets are resold through Ticketsnow.com alone. Not only has law enforcement been absent online, he says, but prices have been higher in states with antiscalping laws, while the number of transactions has been lower. Fluhr, though condemning the illicit use of his site, conceded that the laws are "great for our business." What his customers don't realize, though, is that sometimes it's better to deal with the hawkers on the street. Jim observed that on the night of the Green Day show, street-corner sellers barely recouped face value. **David Talbot**

## Who Wants Tickets?





## Sunburn Alert

### UV SENSORS//

I've long relied on the three-beer rule for limiting my sun exposure during the summer, but a skin patch called **SunSignals**, which changes color when exposed to sunlight, showed that I could fry my epidermis faster than I could drink a single brew.

The thumb-sized, yellow adhesive patches are designed to turn dark orange when they have absorbed a certain amount of UVB light (the type of ultraviolet radiation that causes sunburn), telling wearers to get out of the sun, put on more clothing, or slather on more sunscreen. (The sensors are not meant to replace sunscreen.) With more than one million new cases of skin cancer diagnosed each year in the United States, the patches are a sensible reminder of our fragility.

Unfortunately, my patch changed color after only 17 minutes in the Los Angeles sun, barely enough time to finish a drink. My companions fared a little better, lasting 23 and 27 minutes before the sun-fear factor kicked in. While the kids in our group got a fun science lesson from the stickers, SunSignals seem more of a novelty than a technological breakthrough. It's still up to sunbathers to decide whether they trust the sensors and want to keep reapplying sunscreen every 20 minutes. SunSignals are available in selected drug stores and supermarkets; a package of 18 can be bought online for \$4.99.

Anita Chabria

# The Shape of Things to Come

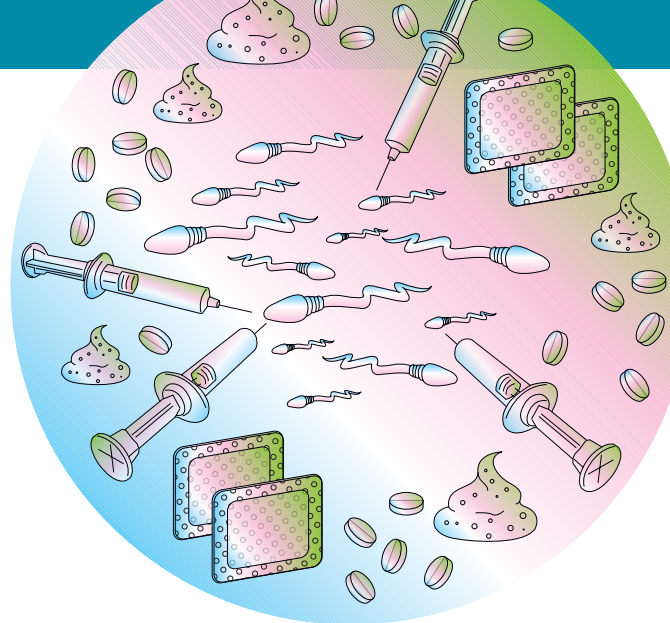
## BOOK //

Bruce Sterling has enlightened emerging-technology watchers for almost 30 years, first as a science fiction author and later as a journalist. His latest nonfiction book, **Shaping Things**, is a rambling, rambunctious exploration of the future of humanity and its relationship with technology. Sterling describes two scenarios: one where technology helps establish social justice and create a cleaner, safer, richer world, and another where we lose control over how technology is used. Which scenario we end up with depends on how we, as a society, design future information networks and the devices connected to them.

In much of the book, Sterling describes how we are approaching the new age of "Spimes," which he defines as free-flowing data that can be easily plucked and processed by "Wranglers" (what we call end users today) wherever and whenever they are needed. The networks and machines that store and carry the data will be so intelligent that interacting with them will be automatic. Maintaining this constant, free flow of information will require

that everyone is able to interact with, modify, and rerelease applications within the network. If governments and corporations are made responsible for designing future networks, technological development will slow drastically, and the few, rather than the many, will control access to information.

Despite Sterling's insistence, near the conclusion, that he isn't arguing for a utopia, the book reads like a religious primer, one meant to appeal to the emotional ideals of hackers and help them redouble their open-source and free-software development efforts. Sterling's arguments are quite different from the legal framework Lawrence Lessig presents in *Code and Other Laws of Cyberspace*, Richard Stallman's advocacy of free software, and Nicholas Negroponte's technology-for-all stance. While all of these utopian visions tend to be idealistic, Sterling's is the most practical. He doesn't completely rule out governmental and corporate control of information technology; he just calls on citizens to exert greater influence over its design, which, if done correctly, should free us from the drudgery of maintaining networks and machines and give us time to work toward the common good. The book will be released in October and sells for \$21.95. **Brad King**



## Shooting Blanks

### MALE CONTRACEPTION //

For better or worse, modern science has left women responsible for all but two methods of birth control. Women, I'm sure, would love to offload some of that responsibility on men. The problem is that many men dislike condoms, for obvious reasons, but consider vasectomy a little too permanent. So far, their gender hasn't had any alternatives.

But soon it might, in the form of a male variation of the birth control pill. The first medicinal male contraceptive will likely be a subdermal, hormone-releasing implant, and it could be available in five years. The hormone is progestin, which is also found in the current women's pill. In men, it blocks chemical signals from the pituitary gland that tell the testes to secrete testosterone and produce sperm. Of course, low testosterone can mean mood swings, dwindling sex drive, and the ego-sagging possibility of shrunken testicles. So supplementary testosterone will be necessary.

The most advanced clinical trial—which began early last year with 350 European men and is run by the drug companies **Schering** and **Organon**—is testing matchstick-sized implants in the upper arm. Testosterone is injected in the buttocks every 10 to 12 weeks. In the trial, a doctor gives the shots. However, a prescribed product will allow women to, literally, stick it to a husband or boyfriend.

Earlier trials showed that progestin stops sperm production in most men, but only after two months of treatment. Sperm-making is back to normal within three months of the treatment's end. In these trials, the treatment was about 98 percent effective in preventing pregnancy, a rate comparable to the female pill's.

It's questionable to what degree men will want a drug that interferes with the production of their beloved testosterone. Even if men agree to the drug in principle, they may not go for the implants and needles. Those men who prefer their own pill will have to wait at least 10 years before it becomes available. **Stu Hutson**

# The Dream of a Lifetime

## Doug Engelbart and augmenting human intellect

BY BILL JOY

**Y**OU'VE LIKELY HEARD stories about the birth of the PC: of Xerox PARC as the Mecca of computing; of its creation of the Alto, Ethernet, and the laser printer; of the Homebrew Computer Club, the MITS Altair, Bill Gates and the theft of his Microsoft Basic; of Steve Jobs and Stephen Wozniak, the founding of Apple, and the Jobs visit to PARC that inspired the Macintosh.

But what you may not know about is the *really* early history. The stories of Doug Engelbart and John McCarthy, of the Augmentation Research Center, and of the early days of the Stanford University AI Lab (SAIL) are not well known. Yes, you may have heard that Engelbart invented the mouse, and that SAIL and Stanford led to companies like Sun and Cisco. But there are better stories, great and old ones from the early days of computing, about the events that led to personal computing as we know it.

In his wonderful new book, *What the Dormouse Said...*, John Markoff tells these stories. Markoff was born in Oakland, CA, and has been covering Silicon Valley for the New York Times for more than a decade. From a distinctly West Coast perspective, *Dormouse* chronicles the origins of the personal computer and its place in the Bay Area culture of the 1960s. Having lived, intensely, the later part of this story, I am fascinated by the great back stories of people I came to know and, often, work with. Many of these stories were only vaguely familiar; many more, I'd never heard.

### Engelbart's Dream

The central figure in *Dormouse* is Doug Engelbart, whose long-time passion was to build a working version of Vannevar Bush's "Memex" machine. In the 1940s, while working in Washington, DC, as director of the Pentagon's Office of Scientific Research and Development, Vannevar Bush had imagined a "machine that could track and retrieve vast volumes of information," and he wrote about his idea in the July 1945 issue of the *Atlantic Monthly*:

"Consider a future device for individual use, which is a sort of mechanized private file and library. It needs a name, and, to coin one at random, 'memex' will do. A memex is a device in which an individual stores all his books, records, and communications, and which is mechanized so that it may be consulted with exceeding speed and flexibility. It is an enlarged intimate supplement to his memory."

Engelbart encountered the idea of the Memex while serving as a radar technician in the U.S. Navy during World War II. It took root in his imagination and, in 1950, he had an epiphany,

one that guided him and his work for the next two decades. Markoff writes that Engelbart

"saw himself sitting in front of a large computer screen full of different symbols....He would create a workstation for organizing all of the information and communications needed for any given project....he saw streams of characters moving on the display. Although nothing of the sort existed, it seemed the engineering should be easy to do and that the machine could be harnessed with levers, knobs or switches. It was nothing less than Vannevar Bush's Memex, translated into the world of electronic computing."

Engelbart earned a PhD in electrical engineering from the University of California, Berkeley, in 1955, and was soon working at the Stanford Research Institute (SRI). There, he came across a paper called "Shrinking the Giant Brains for the Space Age," which had been presented at a conference in June 1959. Its author was Jack Staller of the aerospace firm American Bosch ARMA, who had written, prophetically,

"The problem is to compress a room full of digital computation equipment into the size of a suitcase, then a shoe box, and finally small enough to hold in the palm of the hand....Forming on the horizon are solid state circuits or

### Great Time

#### ***What the Dormouse Said...: How the 60s Counterculture Shaped the Personal Computer Industry***

By John Markoff  
Viking, 2005, \$25.95

the growing of the whole circuit on a single small solid-state wafer and molecular film techniques where films millionths of an inch thick and equally narrow conductors are built up layer over layer to form whole sections or perhaps complete computers in fractions of cubic inches."

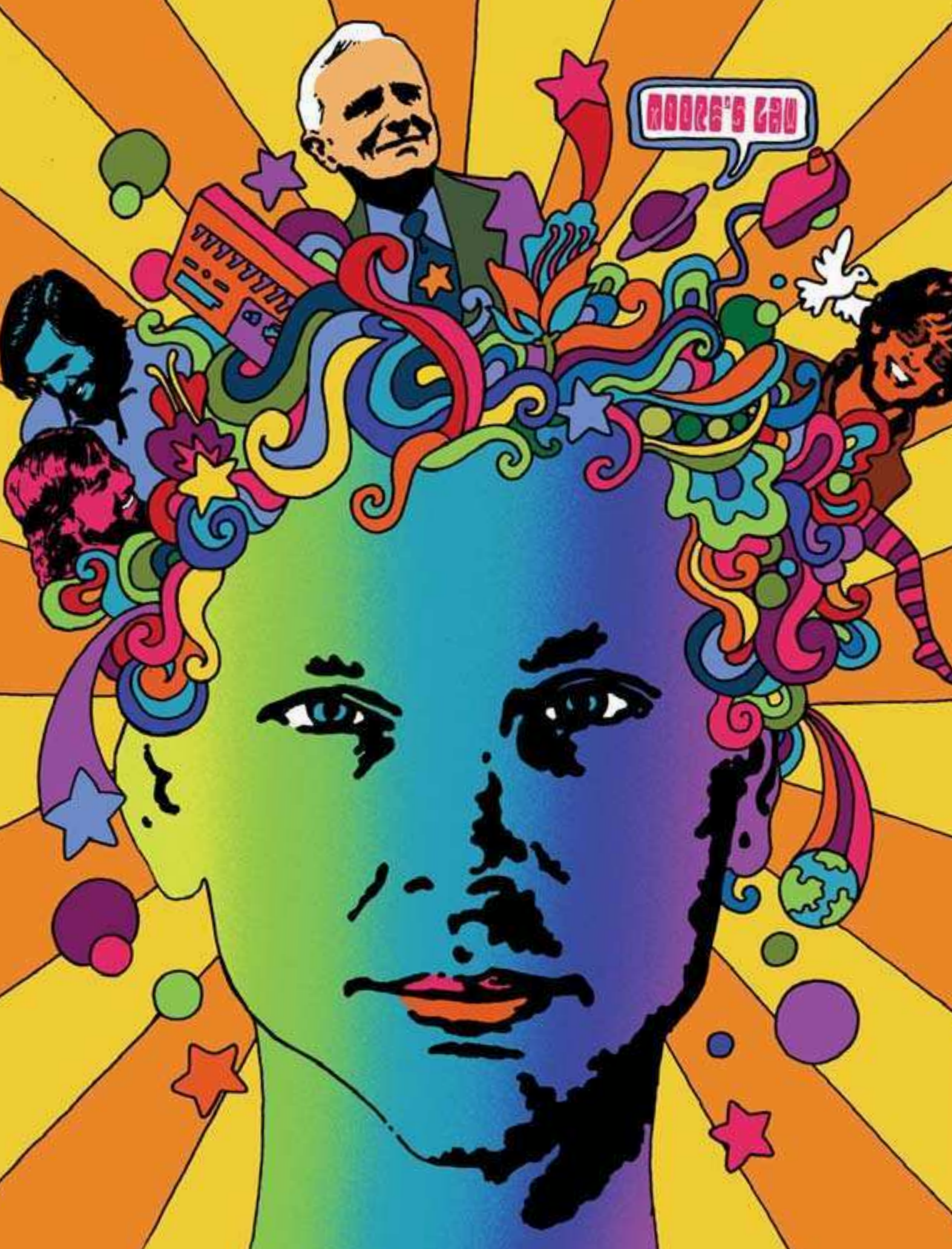
Then, as Markoff relates, in February 1960, five years before Gordon Moore published an article in *Electronics* magazine whose assertions would become known as "Moore's Law," Doug Engelbart came to the same conclusion that Moore would: that a relentless and inevitable increase in computing capacity would result from the continuous shrinking of the transistor. And he saw that with this increase in capacity, computers would soon be powerful enough to augment the human intellect. This dream—Engelbart's dream—has led to computing as we know it.

Engelbart found funding from visionary program managers in the federal government, people such as the U.S. Defense Advanced Research Project Agency's J. C. R. Licklider, who envisioned computers as a communications tool, and NASA's Bob Taylor, who later assembled and led the great group of computer scientists who headed Xerox PARC. With their support, Engelbart, from 1960 to 1968, led a team at SRI that implemented a prototype system demonstrating his ideas.

The high point of *Dormouse* is Markoff's recounting of Engelbart's first public presentation, in December 1968, of his "oNLine System" (NLS). Markoff writes,

"In one stunning ninety-minute session, [Engelbart] showed how it was possible to edit text on a display screen, to make hypertext links from one electronic document to another, and to mix text and graphics, and even video and graphics. He also sketched out a vision of an experimental computer network to be called ARPAnet and suggested that within a year he would be







# Reviews

able to give the same demonstration remotely to locations across the country. In short, every significant aspect of today's computing world was revealed in a magnificent hour and a half.

"There were two things that particularly dazzled the audience:...First, computing had made the leap from number crunching to become a communications and information-retrieval tool. Second, the machine was being used interactively with all its resources appearing to be devoted to a single individual! It was the first time that truly personal computing had been seen."

## The 1960s: Drugs and Protest

*Dormouse* describes how political, social, and cultural forces came together to shape the early personal-computer industry on the West Coast: Engelbart and his colleagues were part of a community that included early experimenters with LSD and leaders of the antiwar movement.

Despite today's conservative backlash against much of what the 1960s' countercultural movement stood for, the Internet and the personal computer have been accepted, and they give us great tools to spread awareness. Though these tools can also be used to amplify propagandizing, there is reason to believe that they will ultimately give advantage to the truth. In this, the spirit of the 1960s' struggle lives on.

Some who read Markoff's book may feel nostalgic for the drug culture that developed alongside the personal computer, but I do not. For me, the stories about drug experimentation are sad stories of a quest gone awry. The promise was that LSD and other drugs would expand our creativity. But like other abused substances, including alcohol and, now, in America, even food, they have largely brought us personal tragedy. In the end, drugs such as LSD and marijuana give most users, not new creativity, but merely the personal and temporary presumption of the new, and at great personal cost.

The personal-computing and Internet revolutions have produced much of what the drug experimenters were seeking. They have given people long-sought enhancements of the ability to communicate and to learn. And now, with so much accessible to so many people through the Internet, we see hope for the expansion of creativity itself, and for the raising of collective consciousness. The Internet promotes creativity not through solitary, short-lived experiences, but through the use of a real, permanent, and shareable medium. It offers new awareness through access to the firsthand truth about what is going on in the world—if its users take the time to separate the truth from the flood of mass media and junk that the Internet also brings.

## Other Dreamers

*Dormouse* tells the important story of what the Bay Area did for computing. But as I read the book, I found myself thinking about other early history, stories not centered on the West Coast. While the PC was born in California, its conception required important contributions from other parts of the country.

Today, PCs are highly networked, run multiple applications at the same time (much as the time-sharing computers of the 1960s and 1970s supported multiple users), and have virtual memory to

support large applications. These and many other key technical capabilities originated not in the counterculture of the West Coast, but in the great universities and research labs on the East Coast, in England, and even in the upper Midwest, where I grew up.

Around the time of Engelbart's NLS presentation, a practical implementation of a different set of groundbreaking computing concepts, far beyond a mere demonstration, appeared in the form of the Michigan Terminal System (MTS) operating system.

MTS was written for a mainframe—the IBM 360/67—that was one of the first computers to have virtual memory. IBM had 500 programmers writing a new operating system for this computer, but they were far behind schedule. So the staff at Michigan wrote MTS, which featured time-sharing, support for virtual memory, file sharing with protection, and many other functions in new combinations that were eventually to become key parts of the PC.

By 1967, MTS was up and running on the newly arrived 360/67, supporting 30 to 40 simultaneous users. Fully a year before MTS was finished, in 1966, Michigan began a related project, the Merit network, which would provide a way to network multiple systems. Like the early ARPAnet, Merit used minicomputers—Digital Equipment Corporation's PDP-11s—to connect larger machines to each other.

By the time I arrived as an undergraduate at the University of Michigan in 1971, MTS and Merit were successful and stable systems. By that point, a multiprocessor system running MTS could support a hundred simultaneous interactive users, as well as remote graphics applications on computers such as the DEC 8/338 and 9/339—pioneering minicomputers with interactive vector graphics displays. MTS served as a campuswide network for these machines, and Merit soon connected the computers of the University of Michigan with those at other universities.

Similarly powerful systems were built on Digital Equipment PDP-10s at MIT, Stanford (SAIL), and Carnegie Mellon University, often, like Engelbart's NLS, with support from federal research funds. Markoff recounts in passing what I had forgotten (if I ever knew it)—that Steve Jobs and Steve Wozniak were hanging out at SAIL long before the famous Jobs visit to PARC. SAIL, and similar systems, had much greater importance in the birth of the PC than is generally acknowledged. In my view, these systems underpin, as much as Engelbart's work does, personal computing.

## True Augmentation

Engelbart's dream came true because Moore's Law held. Those who believed in the law often succeeded. They saw, as Engelbart did, that computing was destined to become cheap and therefore widely available. It was these people who gave rise to a new wave in computing: the PC industry. Those people who did not foresee the impact of the relentless miniaturization fared less well; thus nearly all of the companies in the previous wave—the mini-computer industry—failed or were acquired.

Most of today's best thinkers on the subject agree that Moore's Law has 10 or more years yet to run. If they're right, transistor density will in 10 years be about 100 times what it is now. In thinking about the future of computing, in hoping for further augmentation of the human intellect, do we understand what another 100-fold increase in computing power will mean? It should en-

able big new dreams. Let me suggest some, which might fuel the next part of the story of personal computing.

Engelbart imagined a figure called an “augmented architect”:

“Let us consider an ‘augmented’ architect at work. He sits at a working station that has a visual display screen some three feet on a side; this is his working surface and is controlled by a computer (his ‘clerk’) with which he can communicate by means of a small keyboard and other devices....Every person who does his thinking with symbolized concepts...should be able to benefit significantly.”

Are we taking full advantage of the power of computers to augment our intellects? I don’t think so. Computers are currently unaware of their environments—of the people and objects around them. The computer does not have cameras to see what we see, to know what books and papers are in the room. We don’t interact with the computer in natural ways—for instance, by drawing on paper (while the computer watches with its camera) or on electronic paper (on which the computer could draw too). We don’t talk, listen, or gesture to computers the way we do to each other.

And we’re no better at entering into the computer’s environment than it is at understanding ours. The best commonly available immersive technology we have today is the video game, not the architectural design package. We, sadly, spend much more of our collective energy and focus on virtual reality for entertainment than for education and augmentation.

Worst of all, computer software doesn’t really interact with us. It executes what we request but doesn’t initiate actions on its own. Our computers do not understand the goals of the projects we’re working on. They don’t think ahead and work, unprompted, in concert with us toward those goals. In reality, we work alone.

We have, or will soon have, sufficient computing power to build interactive, immersive, and aware software, so that the rooms in which we work, as architects or engineers, scientists or students, can routinely become immersive and interactive environments. We need to sponsor the hard research needed to make this dream a reality—to find and to fund the dreamers.

### Your (Pocket) Personal Computer

Nearly 50 years ago, J. C. R. Licklider imagined computers as a communications device. When we look at today’s smart mobile devices, the BlackBerries and the Treos and the Nokia Communicators, we underestimate their importance. Their capabilities are relatively limited. Compared to phones, they’re big and bulky, but compared to notebook computers, they have frustratingly small screens and keyboards. Few people have them. They don’t really feel like our most personal computers.

But I think they are. The power of such devices will grow rapidly, as did the power of the PC. And they will become intensely personal, because they will be able to do more for you than anything that is as portable. They will thus naturally become the focus of improvements in connectivity and communication.

Much as the Google query you make from your home runs on machines located elsewhere, software run on behalf of your pocket PC could reside in remote server farms, on computers you time-share with others—but that you don’t have to maintain.

Does this mean that desktop PCs as we know them will disappear? I’m not suggesting that. Rather, I think, we will find that these larger computers with keyboards become less personal, become shared devices. In my household, many of us have accounts on several different computers, which share our personal information among them. None of these is “my” computer, yet all are, when they need to be. The individual machines are becoming access points to my presence on the network.

Your smart phone will benefit greatly from the next 100-fold improvement bestowed by Moore’s Law. It can acquire more sensors, becoming a personal medical scanner, tricorder, translator, recorder, and interpreter. There are many worthy dreams for such devices!

**Are we taking full advantage of the power of computers to augment our intellects? I don’t think so. Computers are currently unaware of their environments.**

### Note to Government: Think Big

Engelbart’s research found strong support from the government. But that was a long time ago. Federal funding for speculative research

has now, largely, dried up; agencies looking for short-term paybacks now typically sponsor work on specific problems rather than the kinds of pure research, of unfettered thinking, that leads to the birth of whole new industries, as Engelbart’s did.

During the Clinton administration, I served as cochair of the President’s Commission on Information Technology (PITAC). Fellow members of the committee and I recommended that the government think big and recognize that computers will be key to all economic growth in the future, not just the growth of the computer industry itself. We argued that there were industries where, without new computer applications, the United States would become substantially less competitive.

Historically, the most cutting-edge research in computing was sponsored for national defense, with a very long-term view. We recommended that the government fund, in a similar way, a number of large computing projects. Each of these projects would cut across disciplines and make different assumptions (call them guesses) about what the future would be like. Each would create an imagined environment and determine what it would be like to live in it. The projects would result, we hoped, in inspirational prototypes, NLS-like demonstrations of how the great advances in computing and communication, the next 100-fold improvement, could be put to use by the next generation of Engelbarts.

The committee’s recommendations were not followed. Though a President Gore would have been supportive of them, the current administration has not been, and the long-term trend toward a short-term focus in government-sponsored research continues. The young Doug Engelbarts of today will be hard pressed to find support for their dreams.

What a shame. It’s possible now, more than ever, to augment human intellect. We should boldly set our sights on Engelbart’s goal. John Markoff has done us all a great service by writing a book that reminds us of the great value of thinking big. ■

*Bill Joy was the architect of Berkeley Unix and a cofounder of Sun Microsystems. He is now a partner at venture-capital firm Kleiner, Perkins, Caufield, and Byers.*



# Abused Substances

**The “stepfather of ecstasy,” now 80, believes psychedelics are unfairly anathematized. Tripping, he says, has medical and spiritual uses.**

BY ALEXANDER T. SHULGIN

**P**SYCHOACTIVITY IS A broad term for the action of the many chemicals that affect the function of the brain. There are many classes of these substances, such as stimulants, anesthetics, sedatives, narcotics, depressants, antidepressants—and also psychedelics. The mechanism of action of such drugs always involves psychoneurological systems. Medically valuable psychoactive drugs are most often discovered in animal behavior experiments, and finding out how the drugs work frequently calls upon sophisticated research using appropriately radio-labeled synthetic samples.

But for the past four decades, I have studied psychoactive drugs at the far end of the spectrum: those that affect the *mind*. These substances are usually discovered by people experimenting on humans. Rats have brains, and we can remove them, cut them into slices, and see where experimental drugs have gone—but I am not sure rats have what most people think of as minds.

It should be stated outright that the uses of these drugs are not merely recreational (although of course they are used that way all the time, and for other, more meditative reasons). Recently, several researchers successfully navigated the bureaucratic paperwork necessary to get approval of and permission for clinical studies of psychedelics. A study by Francisco Moreno at the University of Arizona using psilocybin in the treatment of obsessive-compulsive disorder has been completed. And two other studies of psychedelics are under way: one, at the Harbor-UCLA Medical Center, is exploring psilocybin as a treatment for anxiety in patients with advanced-stage cancer; the other, being conducted in South Carolina, studies the treatment of post-traumatic stress disorder patients with MDMA—the drug more commonly known as ecstasy. Additional studies should soon be up and running, including one at Harvard’s McLean Hospital that will investigate the potential value of MDMA in treating cancer patients’ anxieties.

I choose to call these psychoactive compounds psychedelics, but many names have been used for them. Originally they were called psychotomimetics, which meant, literally, drugs that produced a state that imitated psychosis. This was soon superseded by “hallucinogens,” which is a more acceptable term but equally inaccurate. The actions of the psychedelics can involve visual phenomena (color enhancement, shape distortion, unexpected interpretations), but these are recallable from memory—there is none of the amnesia that often accompanies a true hallucination. Other terms have been used, such as entactogens (touching within), empathogens (creating empathy), and entheogens (discovering God within), but I still prefer “psychedelics.” It may be offensive to some people, but at least they know what I am talking about.

The very first psychedelic I experienced (this was 45 years ago) was the peyote-cactus alkaloid, mescaline. It was an awesome experience in several ways. But its most dramatic result was my realization that there was no way the forgotten memories of my childhood that had just resurfaced, and the display of colors of which I had previously been unaware, could be contained in a few hundred milligrams of a white crystalline powder. To me it was inescapable that all the richness of that day had been inside my mind all along, and the drug was just the catalyst that gave me access to it. Since I am a chemist, I can easily synthesize chemicals with subtle structural differences—like a slightly longer carbon chain here or a sulfur in place of an oxygen there—to find the dosages where they become active.

Two or three examples. When I moved one of the methoxy groups of mescaline to an adjacent position, and replaced another one with an ethyl group, I got a beautiful white solid that I named 2C-E. It was fully active in me at 20 milligrams taken orally. The visual activity and color enhancement it effected were very much like those of LSD, but 2C-E had a strange and (for me) novel property. On occasion, during a psychedelic experience, I

would ask myself an important, private question to see what answer might bubble up. If the question turned out to be too complex, or touched on unpleasant subjects, I would drop it and ask another. But 2C-E wouldn’t let me do that. I had to stay with each question until I worked through to an answer.

## Compound Interests

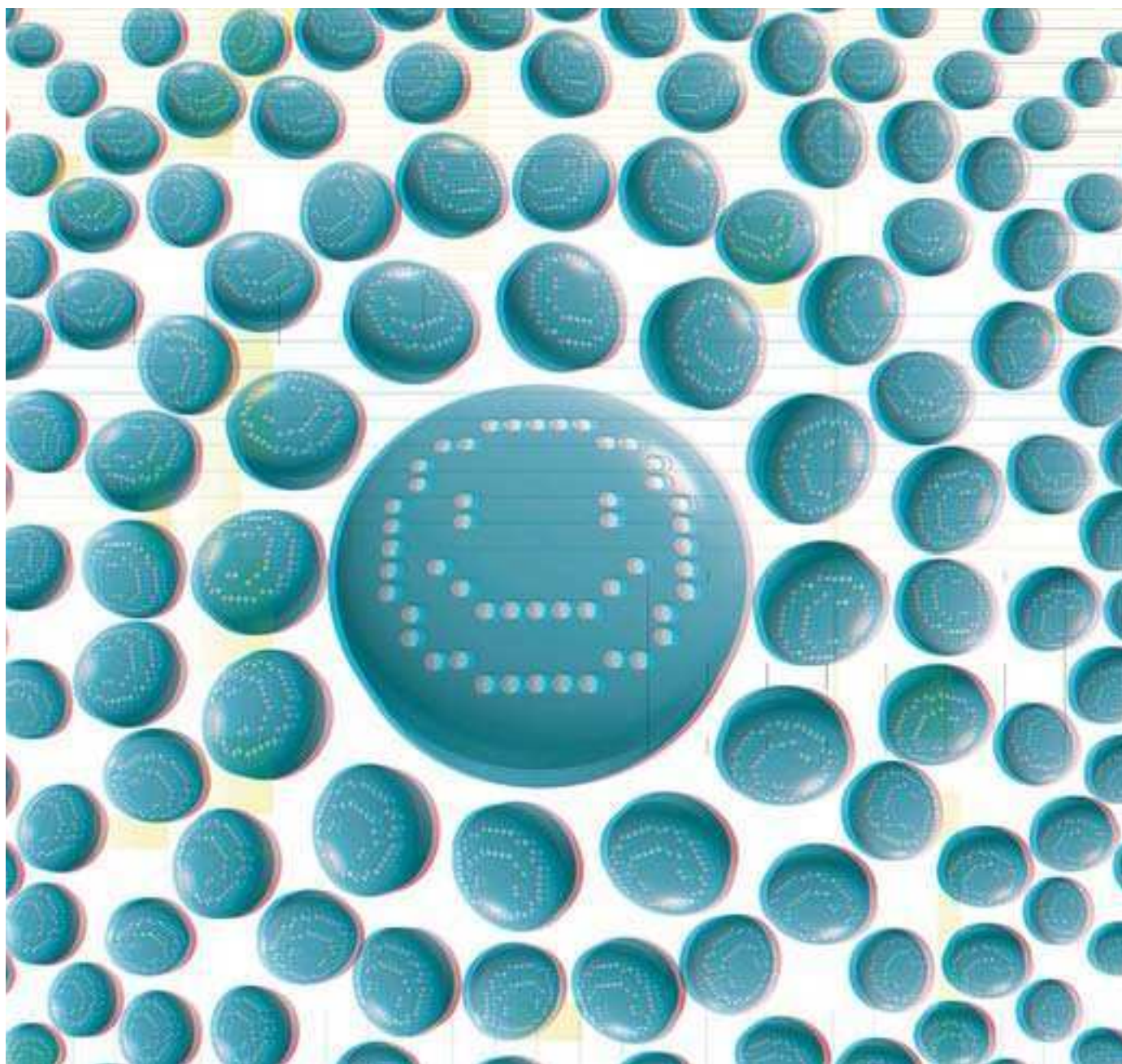
**2,5-dimethoxy-4-ethylphenethylamine (2C-E)**

**N,N-dipropyltryptamine (DPT)**

**Alpha,O-dimethyl serotonin (O-DMS)**

Another example, this one from the other family of psychedelics, the tryptamines. N,N-dipropyltryptamine (DPT) was first synthesized and found to be active in humans by Steven Szara back in 1962. But it exhibits an unusual property if the three-carbon propyl groups are attached to the nitrogen atom by the middle carbon rather than by the end carbon atom. This turns them into isopropyl groups. So I made the compound and called it DIPT. It both lowers and distorts the pitch of sound.

Another example of a subtle modification of a tryptamine molecule involves the well-known neurotransmitter serotonin. Although it plays a major role in enabling neurons to communicate, it cannot enter the brain from the body. There is an effective obstacle called the blood-brain barrier that blocks the passage of most highly polar molecules, although some—certain amino acids and sugars—can get across it because they have specific transport allies. The serotonin-precursor amino acid is one of these exceptions, and once it has gotten into the brain, serotonin can be made from it. Since serotonin is implicated in the effects of most psychedelics, I changed it a little bit. On the right-hand side of the molecule is a primary amino group. Upon the oxidative loss of this amine, the molecule metabolizes rapidly to a carboxylate group, which is very polar. So I added an alpha-methyl group to block that deamination. On the left-hand side of the molecule is a polar phenolic hydroxy group. By converting it to a methyl ether, I neutralized its polarity. I called the compound alpha,O-dimethyl serotonin, or O-DMS (it was also called 5-MeO-AMT for 5-methoxy-alpha-methyltryptamine). Surprise!



It turned out to be orally active in the low-milligram range. In my research group, each person took a sample weighing somewhere between 2.5 and 4.5 milligrams, and all had trips that lasted more than 12 hours. Almost all, once they were finally able to get to sleep, had nightmares.

I have little insight as to how these remarkable compounds do what they do. The human mind is a mysterious and complex thing. There have never been dependable ways to get into it, take it apart, and see how it works. My hope is that psychedelic compounds may be the tools, or may lead to the discovery of tools, that can throw some light on elusive questions about how the mind works. Say a person is called “mentally ill” because he hears God speaking to him. Maybe you can put a positron emitter on a chemical that gives you distortion in sound recognition, inject it into a normal subject who is in a PET scanner, and observe that it goes to a most unusual place in the brain. Maybe

that is where the physician should look for the tumor in the brain of the person who hears from God.

One of the major impediments to the expansion of research in this fascinating area is the war on drugs. The categorization of psychedelics as evil and dangerous keeps them in the Schedule I category, where they are said to have no medical value. Discoveries are not being published, because researchers feel that if new and potentially useful compounds are openly discussed in the medical literature, the U.S. Drug Enforcement Agency will add them to the illegal list. With the series of clinical trials using psychedelics, I hope the wind is shifting. ■

*Alexander “Sasha” T. Shulgin is a pharmacologist and biochemist who popularized ecstasy in the 1970s. He was the first to synthesize hundreds of psychedelic compounds, including the 2C family of phenethylamines, most of which have never been made illegal.*



# Hypermotivational Syndrome

Many young people are using drugs not to drop out but to get ahead.

**R**ECENTLY, THE Partnership for a Drug-Free America recently gave its imprimatur to a new buzzword: *Generation Rx*. Its annual report on what Americans think of controlled substances showed that for the first time, more teenagers are abusing prescription painkillers than are using a variety of common illicit drugs.

What are these prescription drugs being used for? Some of them mimic the effects of street drugs. For instance, the pain reliever Oxycontin, when stripped of its coating, can produce a heroinlike high. The consequences of this kind of abuse are familiar. Antidrug advocates have warned for decades that drugs impair not only users' health but also their work. Drug-induced torpor even earned its own name: amotivational syndrome. Timothy Leary's flameout on the Harvard fast track probably frightened more middle-class parents than the warnings of J. Edgar Hoover.

But there is an aspect of prescription drug abuse mentioned only briefly in the report: ingesting to excel, not rebel. There's now a *hypermotivational syndrome*, use of prescription drugs not to escape the commanding heights of education and the economy but to attain them.

The powers that be have long blessed chemical performance enhancement. Employers once encouraged stimulants: a hundred years ago, African-American dock workers in the South were given cocaine to fuel their back-

breaking labors. In the Southern textile industry, traveling "dope wagons" brought milder stimulants like caffeinated, sugary soft drinks and snuff to mill hands. The U.S. armed forces distributed cigarettes to help servicemen cope with the combat stress of World War II. Amphetamine use by military flyers began at the same time and persisted even during later antidrug campaigns, though at lower dosages, with stricter controls.

Returning veterans stayed with tobacco; their grandchildren are looking elsewhere for a mental boost. For students with full-blown attention deficit/hyperactivity disorder (ADHD), Ritalin can be a miracle. In 2000, *People* magazine profiled a Rhodes scholar who had overcome ADHD as well as dysgraphia—the inability to organize, spell, or write legibly—partly by taking Ritalin.

It is thus not surprising that non-ADHD students often try to persuade family doctors to prescribe off label. Failing that, some students buy pills on a growing black market. A junior at Yale University claimed that, fortified with Adderall, he read *Crime and Punishment* and completed a 15-page paper on it in about 30 hours. The drug is "more efficient" than caffeine, he told an ABC News correspondent. And Modafinil, also

sold as Provigil, lets military pilots remain alert during prolonged missions without the perilous feelings of omnipotence or the addiction risk sometimes linked to the older amphetamines.

Why is there so much passion for enhancing memory and decision-making and so little for firing the imagination? Until the American Medical Association declared its opposition to LSD research in 1963, leading to U.S. Senate hearings in 1966 that resulted in a virtual ban, prominent medical researchers and artists embraced it as a possible means of therapeutic insight and expanded creativity.

LSD was marketed to psychiatrists by the Swiss pharmaceutical giant Sandoz.

**Non-ADHD students often try to persuade family doctors to prescribe Ritalin and other drugs off label. Failing that, some students buy pills on a growing black market.**

At first the drug was widely acclaimed as a promising therapeutic tool. In Saskatchewan, a psychiatrist, Humphry Osmond, and an architect, Kyio Izumi, ingested LSD in an attempt to empathize with schizophrenia patients while co-designing a new mental

hospital. Aldous Huxley and Allen Ginsberg praised LSD as a source of knowledge. John Markoff's *What the Dormouse Said...* reports that, in the early 1960s, Myron Stolaroff, a former Ampex employee, founded an institute that recruited volunteers, including some of the electronics industry's brightest researchers, to explore LSD's potential to stimulate creativity. Many became believers. (Bill Joy reviews *Dormouse* on p. 76.) A founding programmer of Microsoft told the *Washington Post* in 1996, "I consider the insights from LSD to be very useful, both professionally and personally." The circle of distinguished people taking LSD constituted a veritable hallucinogeny.

The moment didn't last. The dangers of LSD-induced psychosis and even death were real. Imagination-enhancing substances were outlawed by the late 1960s. And proscribed they have remained. Yet the newer drugs also have their risks, especially psychological dependency. They compete with proven nonpharmaceutical techniques like meditation. Taken indiscriminately, they may not provoke users to leap out of windows, but they could lead them to shut some doors. ■



ANDY POTTS



# From the Lab

A good place to look for the important technologies of tomorrow is in the scientific discoveries of today. Based on recommendations from academia and industry, *Technology Review* has chosen these peer-reviewed papers as ones that may one day inspire the development of those technologies.



## INFORMATION TECHNOLOGY

# Digital Illumination

Graphics technique allows movie-scene lighting after filming

**RESULTS:** Researchers led by Paul Debevec at the University of Southern California's Institute for Creative Technologies have developed computer graphics tools that let filmmakers simulate the live-action lighting conditions of settings that their actors were never in, or add new lighting effects to film they've already shot. The researchers previously showed that they could change lighting effects in still images.

**WHY IT MATTERS:** Movie directors use computers to adjust and create visual ef-

fects, but for the most part, they can't tinker with lighting. That means they have to get the lighting just right during filming—a time-consuming and expensive process. The ability to change or re-create lighting after a performance can give filmmakers more flexibility in making the movies they want, while potentially saving time and money on the set.

**METHODS:** The researchers placed an actor inside a spherical structure two meters in diameter that was lined with 156

bright LED light sources. As the actor performed, different lights flashed on and off thousands of times per second, either singly or in groups. A camera filmed the actor at a frame rate equal to the rate at which the lighting changed, so that each frame was lit in a different way, for a maximum of 180 different illumination conditions. The researchers filmed the actor's head and shoulders, recording up to eight seconds of action; downloaded the information to computers; and used algorithms to select and superimpose different frames to create desired illumination effects.

But there was a problem. Although the actor was filmed at a high frame rate, and the lights flashed just as quickly, the actor still moved appreciably while each of the 180 lighting conditions was being captured. This meant that the position of the actor differed slightly in each frame, so superimposing the frames resulted in smeared images. To solve this problem, the researchers used computer vision algorithms to track and analyze the actor's facial movements. Based on estimates of how the actor was moving in a given set of frames, they digitally warped the image data to make it look as if each of the 180 frames was taken at the same instant. They repeated this process to produce a set of frames showing the 180 individual lighting conditions for each 24th of a second of the actor's performance, which they then assembled to produce the final film clip with the computer-generated lighting.

**NEXT STEP:** The researchers would like to build a larger spherical structure with a greater number of brighter lights that could capture images of an actor's whole body or of more than one actor at a time. They are also working on finding the best

# From the Lab

pattern in which to flash the lights on and off so as to obtain the optimum image quality while minimizing the appearance of flickering.

**Corie Lok**

Source: Wenger, A., et al. 2005. Performance relighting and reflectance transformation with time-multiplexed illumination. *ACM Transactions on Graphics* 24:756–64.

## Smarter Search

### Streamlining retrieval on the Web

**RESULTS:** Some Web-search sites like Clusty and Teoma sort results into categories to help users narrow their searches. Researchers at IBM have devised an algorithm that allows search programs to display a wider selection of categories by analyzing the content of a sample of results rather than that of every page. The researchers performed searches of 1.8 million Web pages, analyzing both the entire body of results and the sample populations selected by the algorithm. They found that even when samples constituted only 1 percent of the total results, the algorithm could still capture most of the popular categories extracted from all the results.

**WHY IT MATTERS:** Looking for information online can be frustrating when search terms have multiple meanings and contexts. Sorting results into “clusters” of related topics can help cut search times, but most search engines that use this technique examine only the most relevant few hundred results to extract common themes. So even topics with plenty of pages devoted to them can be ignored in favor of trendier subjects associated with the same keywords: a search for “macintosh” will identify themes prominent on millions of computer-gossip pages but entirely miss those few thousand pages about Charles Macintosh, father of the rubberized raincoat. The sampling methods devised by Aris Anagnostopoulos, now at Brown University, and Andrei Broder and David Carmel at IBM could allow users to quickly find the pages they want, even when their search terms are ambiguous.

**METHODS:** In a large search, collecting a representative sample is not easy. Most search engines assemble results not all at once, but a handful at a time as needed. They first generate a list of matching pages for each keyword in a query. Those lists are merged, about a hundred results at a time, using logical operators extracted from the query—words such as “and” and “or.” The IBM algorithm, on the other hand, simultaneously sifts through these multiple lists, picking Web pages at random and, if they meet all the conditions of the search, adding them to the sample pool. The algorithm takes measures to ensure that each Web page in a list has an equal probability of being chosen. A search engine could use the sample pool to determine sorting themes.

**NEXT STEP:** Devising custom sampling techniques to handle the most common types of queries could yield speedier search results. Anagnostopoulos is also interested in investigating whether, when devising sorting categories, giving less popular pages even more weight leads to better results.

**Dan Cho**

Source: Anagnostopoulos, A., et al. 2005. Sampling search-engine results. Paper presented at the 14th International World Wide Web Conference. May 10–14. Chiba, Japan.

## Sampling Songs

### Digital fingerprints make for easier searching

**RESULTS:** Microsoft researchers have developed software that can automatically identify audio files—including streaming audio—by extracting and encoding short sections of them to form “fingerprints.” Christopher Burges and colleagues have developed two new applications for this audio-recognition technology: identifying duplicate files in a large collection of audio files and creating “thumbnails,” 15-second-long, recognizable snippets of each file. The software found duplicates in a database of more than 40,000 audio files with a 1.2 percent error rate. In another test involving 68 songs, a panel of

users compared thumbnails made with the Microsoft software with snippets of the songs beginning 30 seconds in, and rated the Microsoft thumbnails more likely to contain the titles, choruses, or other distinctive features of the songs.

**WHY IT MATTERS:** Today’s digital-audio libraries are growing in size, and users must manually sort through them to find and remove duplicate files. Microsoft’s method of spotting duplicates could make for easier and faster consolidation of large song collections. Many online music purveyors also offer their customers previews of songs. Currently, those previews are created either manually—someone listens to the song to find a recognizable chorus, then makes the song snippet—or via software that samples only a predetermined segment of each song, which may not contain readily recognizable material. The new software can automatically find the defining part of a song when extracting a thumbnail, making the thumbnail a better indicator of the song’s identity.

**METHODS:** The duplicate detector extracts a fingerprint for each file and puts it into a database. To compare two songs, it considers the location from which the first song’s fingerprint was extracted and looks for a matching fingerprint in the same vicinity in the second song. If it finds a match, it identifies the two as duplicates. After analyzing all the songs in the database, the detector presents the user with a list of duplicate songs.

The thumbnail generator compares fingerprints within a file. If it finds similar fingerprints at different points, it identifies them as the song’s chorus or some other characteristic feature. If fingerprint analysis doesn’t find a clear repeating feature, the software can analyze other aspects of the song, such as patterns of sound frequencies, to pick out a characteristic section. The software then extracts the 15 seconds of audio surrounding that section as the thumbnail.

**NEXT STEP:** The researchers are working with Microsoft’s product teams to commercialize this technology. Potential applications might include software that cleans up music collections on home com-

puters, freeing up disk space. Online music vendors could also use the thumbnail generator to create previews of the songs offered on their websites. **Jean Thilmany**

Source: Burges, C., et al. 2005. Using audio fingerprinting for duplicate detection and thumbnail generation. Paper presented at the IEEE Conference on Acoustics, Speech and Signal Processing, March 18–25. Philadelphia, PA.

## BIOTECHNOLOGY

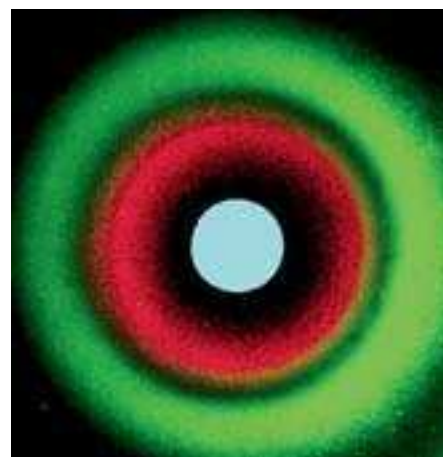
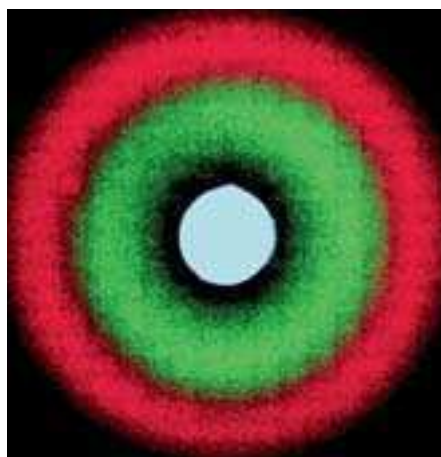
# Bacterial Sensors

Engineered *E. coli* bacteria signal environmental changes

**RESULTS:** Princeton University and Caltech researchers have genetically engineered *E. coli* bacteria to give off red or green fluorescent light in response to different concentrations of a cell-signaling molecule secreted by a third type of *E. coli*. Incubating the three types of *E. coli* in petri dishes resulted in controllable patterns. In one experiment, the researchers produced concentric circles of different colors, with the signaling cells in the center. Surrounding them were two types of fluorescing cells: one that emitted green light when sensing a high concentration of the signaling molecule, and another that gave off red light at medium concentrations.

**WHY IT MATTERS:** Researchers had previously programmed cells to communicate individually or in small groups. Here the Princeton and Caltech team engineered larger populations of bacteria to work together to form visible patterns that could be used, for example, to signal the presence of a toxic chemical. Because the bacteria produce different signals in response to concentrations of a target chemical, they could flag areas of high concentration as likely sources of wider contamination. In theory, bacteria-based sensors could be more sensitive to a broader range of chemicals than conventional sensors are.

**METHODS:** The researchers, led by Ron Weiss and Frances Arnold, used mathematical models of gene activity to predict



Genetically engineered bacteria reveal colored patterns under a fluorescence microscope. Cells in the center (blue) secrete a signaling molecule sensed by the surrounding bacteria. Left: one *E. coli* strain shines green at high concentrations of the molecule, while a second shines red at medium concentrations. Right: a third strain shines green at low concentrations.

the responses of different strains of *E. coli* to distinct ranges of signaling-molecule concentrations. The researchers then synthesized the strains likely to be most useful by inserting into the *E. coli* genome desired genes, such as those that code for fluorescent proteins. They then spread a mixture of these strains in petri dishes containing growth media and incubated them overnight. Using a fluorescence microscope, they took pictures of the plates to reveal the different colored patterns.

**NEXT STEP:** To turn microorganisms into sensors, the researchers must couple their gene networks to receptors that specifically bind to target chemicals. They will also need to design the sensors so that the cells remain alive and stable even outdoors. And they will likely need to devise some kind of control switch to reset or turn off the sensors.

**Corie Lok**

Source: Basu, S., et al. 2005. A synthetic multicellular system for programmed pattern formation. *Nature* 434:1130–34.

## Repairing the Heart

Dividing cells could mend tissue after heart attacks

**RESULTS:** In a study that could have ramifications for heart attack patients, researchers led by Mark Keating at the Harvard

Medical School–affiliated Children’s Hospital Boston have coaxed adult mammalian heart muscle cells into dividing by adding two types of chemicals. One blocks an enzyme called p38 MAP kinase, important in the early development of many types of cells; the others are protein growth factors. Adding these chemicals to rat heart cells in a lab dish induced 7 percent of them to begin dividing. To show that the p38 gene can inhibit heart cell division, the researchers engineered live mice who lacked the gene and found that the duplication and separation of chromosomes in their heart cells—a key step in cell division—increased by more than 90 percent.

**WHY IT MATTERS:** During a heart attack, oxygen-starved cells die, leaving behind damaged tissue. Researchers have long thought that the heart can’t repair itself because its cells can’t divide. This paper suggests that tissue regeneration might be possible. Doctors could potentially administer a drug that triggers heart muscle regrowth in recovering heart attack patients.

Researchers have previously shown that heart cells can divide, but only in strains of lab animals with genetic modifications. Here, the Harvard researchers have shown that they can turn on the cells’ ability to divide using a more therapeutically practical strategy: adding chemicals.

**METHODS:** The researchers studied the effects of p38 inhibition on the major stages of cell division—DNA synthesis, division of the cell’s nucleus, and division of the cell



## From the Lab

itself—in rat cell cultures and living mice. In one experiment, they stimulated heart muscle cells from 12-week-old rats with growth factors in the presence or absence of a p38 inhibitor. They looked for signs of key molecular events associated with the various stages of cell division.

**NEXT STEP:** While the researchers demonstrated cell division in a lab dish, they did not demonstrate it in live animals. They are now injecting the inhibitor and growth factors into rats with damaged hearts and looking for signs of regrowth. The researchers will also have to ensure that they can control the cell growth and avoid causing cancer.

**Corie Lok**

Source: Engel, F. B., et al. 2005. P38 MAP kinase inhibition enables proliferation of adult mammalian cardiomyocytes. *Genes and Development* 19:1175–87.

## NANOTECHNOLOGY

### Superlens Crafters

Lens allows optical microscopy down to 60 nanometers

**RESULTS:** A team from the University of California, Berkeley, has devised a silver “superlens” that could increase the resolution of light microscopy by about a factor of six. The lens doesn’t diffract light like conventional glass lenses. Instead, it uses evanescent waves, which are produced when light hits a lens at such an angle that it bounces off instead of passing through. Evanescent waves emerge on the other side of the lens and add optical information to normal “propagating” light waves, but they decay very quickly over short distances. By capturing and amplifying these weak waves, the researchers obtained images with 60-nanometer resolution.

**WHY IT MATTERS:** High-resolution imaging methods such as electron microscopy can’t image living tissue. Light microscopy can. Its resolution, however, is limited by the wavelength of the light used. And 400 nanometers is the shortest wavelength that doesn’t damage tissue. Evanescent



**Nanoimaging using a superlens. Top: ion beam image of letters etched in chromium. Middle: superlens image of letters on light-sensitive material. Bottom: optical image without superlens. Scale bar: two micrometers.**

waves allow researchers to get around this limitation. The technique could eventually allow researchers to watch, in real time, biological processes such as protein interactions in samples of living tissue—events that can now be studied only indirectly.

Previous research has used evanescent waves to construct images in piecemeal fashion. The Berkeley team, led by Xiang Zhang, has shown that it’s possible to take a clear and complete picture in one shot.

**METHODS:** The researchers made a lens out of a 35-nanometer-thick film of silver. They chose a light source whose frequency matched the resonant frequency of the lens’s surface electrons. The light shone through the word “NANO,” inscribed in letters with a 40-nanometer line width on a piece of chromium through ion beam lithography. When the light hit the lens, the silver electrons resonated with the evanescent waves, boosting their energy. The superlens directed the waves onto light-sensitive material to capture the image.

**NEXT STEP:** The superlens didn’t spread out the evanescent waves enough that the human eye could see the image directly; it had to be observed with an atomic force microscope. Future research will curve the lens so that it can further spread the waves and pass them into, say, a fiber-optic cable. Superlenses might then be integrated into light microscopes.

**Stu Hutson**

Source: Fang, N., et al. 2005. Sub-diffraction-limited optical imaging with a silver superlens. *Science* 308:534–7.

## Nanoprinting

Ink-jet manufacturing for faster plastic electronics

**RESULTS:** Using conventional ink-jet printing equipment, Henning Sirringhaus of the University of Cambridge in England and colleagues built organic-polymer circuits with switching speeds more than 100 times greater than those of existing polymer circuits. They printed circuit features that they estimated to be smaller than 100 nanometers, less than one-one-hundredth the size of the smallest features previously produced through ink-jet printing.

**WHY IT MATTERS:** Thin, flexible, and cheap plastic electronics could have many applications, from solar cells to radio frequency identification labels in product packaging. Ink-jet printing is an attractive manufacturing option because it deposits materials quickly and cheaply over large areas. But so far, it has yielded features no smaller than 20 micrometers, while the features of typical integrated circuits measure tens of nanometers. The Cambridge team seems to have broken the resolution barrier, making ink-jet printing viable.

**METHODS:** The researchers produced their ultrasmall features using a homebuilt ink-jet printer. They deposited a conducting polymer “ink” as droplets on glass. They then chemically modified the droplets’ surfaces so they would repel additional droplets. A second set of droplets was applied; these flowed off of the first set, landing a tiny distance away. That distance represents the smallest feature size this technique can achieve. The researchers laid out transistors: the closely spaced droplets formed electrodes, and an organic semiconductor filled the gap between them. The researchers estimated the width of this gap based on the performance of the transistors.

**NEXT STEP:** The researchers are now using better-performing organic semiconducting materials. They are also producing circuits that involve hundreds of interconnected transistors.

**Corie Lok**

Source: Sele, C. W., et al. 2005. Lithography-free, self-aligned inkjet printing with sub-hundred-nanometer resolution. *Advanced Materials* 17:997–1001.

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## Web Libs

**Build a content filter that rewrites the Web—your way, Mad Libs style!**

**BY SIMSON GARFINKEL AND PETER WAYNER**

If you are one of the many who feel that the media are unforgivably biased, the Web now has a solution for you. Greasemonkey, an add-on for the open-source Firefox browser, can act as a programmable content filter, sanitizing or scandalizing the news before you see it. For fun, we wrote a simple script (detailed below) that lets Greasemonkey rewrite the news ungrammatically, or render it politically incorrect or even offensive. No matter where you stand on the political spectrum, you'll see that Greasemonkey and related technologies are destroying one of the last one-way streets in the media world. While the Internet may be interactive, many of the most trusted and reputable websites still treat readers as passive recipients of content. Pages are rendered on the computer screen more or less the way the publishers intended, and your job is to consume, not to participate.

But of course, Web pages are nothing more than large collections of bits, and bits are easy to flip, cut, and splice. Nothing can stop the data that the New York *Times* or MSNBC sends to your computer from being modified before it is displayed.

It used to be hard to write programs that hacked Web pages in real time. Mozilla Firefox changed that with a plug-in architecture and a series of extensions. One of the best-known Firefox extensions is Adblock, which lets you suppress any website advertisement you choose.

More interesting for the programmer is Greasemonkey, a nifty extension by Aaron Boodman and Jeremy Dunck that lets you write JavaScript programs that can rip apart Web pages on the fly. Greasemonkey hooks JavaScript into the innards of the browser, making it much easier to hack a Web page. This frees

you to concentrate on what's fun—for example, writing a program that inverts a website's stated intent.

That's what we did with Doubletake, a wacky script that subverts a page's original HTML with a list of specified substitutions. It's like Mad Libs for the Web: Web Libs.

If you download Firefox, install Greasemonkey, and activate Doubletake, every Web page you view will be carefully rewritten using words of your own choosing. If a particular politician seems a bit mentally challenged, you can replace his name with "Village Idiot." Or whatever.

Doubtake is engineered to take advantage of built-in JavaScript functions such as the `replace` method, which can act upon the document object containing the HTML for a Web page. Repeatedly calling the `replace` function for each word will rewrite the document. This approach is sluggish. The time required is proportional to the size of the document multiplied by the length of the list of words to be replaced.

To create a snappier version, we used JavaScript's built-in hash tables to store the list of words to be replaced. We preprocessed this list and built a table called `matchTable`, then broke the document apart and replaced every word appearing in the table.

```
if (typeof matchTable[word]!="undefined"){
    ans=ans+matchTable[word];
} else {
    ans=ans+word;
}
```

However long the list of words to be replaced, the `matchTable` function finds each match in a constant amount of time, so the time required is proportional only to the size of the document.

The technologies at work here have more-practical applications as well. For example, Greasemonkey scripts can modify the style sheets that control how Web pages are displayed, so your browser could, say, display all text as black type on a white background in 14-point font size—just the thing for the 20 million Americans who have significant vision problems.

Firefox and Greasemonkey show the inherently democratizing power of open-source software. Giving everyone the ability to rewrite source code is upsetting the balance of power between programmers and users, and between publishers and readers. Of course, website authors who don't want their artistic integrity eroded can fight back: one of the most common techniques for sabotaging end-user control is to put text inside graphics or multimedia Flash presentations. But these tricks make websites inaccessible for the blind (who rely on text readers) and impossible to navigate using cell phones. The battle for the future of mass communication is just beginning.

Code and instructions at [doubtake.ex.com](http://doubtake.ex.com). ■

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